VI-410
Advanced Analyzer

4-Channel
Human Vibration Analyzer
& Real-Time Sound Analyzer

USER MANUAL

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Introduction

With a growing awareness of human vibration hazards in the workplace and with new exposure standards like the EU vibration directive, there is a driving need to observe, monitor, and quantify **H**and-**A**rm vibration, (HAV), **W**hole-**B**ody Vibration (WBV), and noise from the use of power hand tools, transportation, and other equipment. The VI-410 and QuestSuite Professional II is an "integrated system" to measuring Hand Arm vibration, Whole-Body vibration, and sound levels with accurate readings and detailed analysis.

This manual will explain how to conduct human body vibration studies by using the VI-410 and QuestSuite Professional II. It will walk you through the tools you will need from setup, to calibrating, to logging measurements, and analyzing the results.

This chapter will give you a brief overview of what human vibration is, what to measure, and how to measure vibration. An explanation of standards for hand arm vibration and whole body vibration will be discussed to understand the appropriate placement of the transducer when taking measurements. The chapter will conclude with the introduction of the VI-410 keypad and an introduction to QuestSuite Professional II software.

What is human vibration?

People all over the world experience vibration in subways, buses, trains and in the workplace from mechanical machines and hand-held power tools. Human vibration is essentially a type of mechanical motion at a given reference point that effects your body. With machines and hand-tools, vibration is a result of forces inside machines/tools which have moving parts. Machines are made of

parts with different moving reference points with various frequencies and amplitudes.

The effects of hand-arm vibration can be as damaging as loss of feeling in your fingers and joints, also known as hand arm vibration syndrome, which is a degradation of blood vessels and nerves. Some experts believe that once an individual begins to lose feeling and experience numbing in his/her hands that there is no real cure for these adverse effects.

For whole-body vibration, also referred to as head-to-toe, vibration the effects over a period of years can be as damaging as hand-arm vibration syndrome. In whole-body exposure, individual(s) will experience back trauma with severe low back pain and possibly lumbar disc damage.

Due to the severe effects which vibration can have on the physical condition of people, standard committees were formed around the world to provide threshold levels and limit exposure level guidelines to help reduce the effects of vibration on the human body.

What to measure?

Three main standards or guides exist in America which are: American National Standards Institute (ANSI S.34:1987 guide), American Conference of Governmental Industrial Hygiene (Threshold Limit values defined ACGIH-TLV), and the National Institute for Occupational Safety and Heath (NIOSH, 1986). There are two international organizations which define guidelines which are: International Standards Organization (ISO 5349;1986 guide) and the European communities directives for hand arm vibration (HAV) and whole body vibration (WBV).
From the standard boards noted above, human vibration is characterized by magnitude, frequency, duration and direction. (For a detailed look at measurement calculations see Chapter 6, “About Measurements”.)

How to measure?

With the help of the VI-410 and QuestSuite Professional II software, you can quickly set-up the instrument, run studies on human vibration levels, combine representative samples, and analyze the results with exposure time calculator, time history detail, and real-time frequency analysis. The advantages of using the software with the instrument are the ease and usage of a quick setup and the capability of viewing the results in a graphical format including designing personalized charts, tables, and graphs. This advanced software will also print customized reports and enable you to export the data into other software programs (i.e., Microsoft Excel).

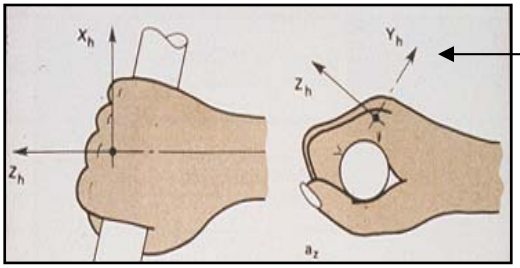
Transducer

A small device, called either a ***transducer*** or an accelerometer, is used to measure acceleration from the hand-held tool, mechanical machine, or device in question. For hand-arm vibration, a transducer is mounted to a device (i.e., hand tool) and then connected to the VI-410 to record the measurements. For whole-body vibration, a seat-pad transducer (or seat-pad accelerometer) is placed on the seat of a vibrating object (seat of heavy equipment or aviation seat) and connected to the VI-410. The VI-410 is then ready to "Start" or run a study. The measurements and the data are then sent to QuestSuite Professional II for analysis of the data or are viewed directly on the instrument. (See Chapter 7, "Taking Measurements" for visual images of this process.)

Direction of measurement HAV

Human vibration is calculated based on up and down motion (through the hand motion), forward and backward motion (along the length of the hand motion), and left and right motion (across the hand motion). These three directions are referred to as an axis and correspond to the x-axis (through the hand), y-axis (across the hand), and z-axis (along the length of the hand).
Why are these three axes of importance? According to ISO 5341 standard, the direction of vibration is measured at each axis. Thus, it is important to place the transducer in appropriate location in order to get accurate readings of hand arm vibration. The diagram below is a good example of how to hold the instrument and place the transducer in accordance to the x-axis, y-axis, and z-axis directions.

✍ ***NOTE:*** *The VI-410 and QSP-II will compute the average of the three axes (called tri-axial) in the vector sum measurement. According to the ISO standards, the vector sum can be used to determine the effects of vibration. Thus, the placement of the transducer when mounted for a study is not of concern unless you are evaluating vibration for engineering controls.*



Direction for X, Y, & Z
- ❖ X-axis – through the hand
- ❖ Y-axis – across the hand
- ❖ Z-axis – along the length of the hand-arm

Figure 1-1: Hand-arm vibration vector coordinate systems (in accordance with ISO standards)

Threshold and Exposure values for HAV

The American National Standards Institute (ANSI), International Standards Organization (ISO), and European Community Directive (EU) uniformly maintain exposure guidelines for hand-arm vibration and are recommended for determining the magnitude of the measured vibration. To access these copyrighted standards, the ISO and ANSI standards can be purchased from www.jso.org or www.ansi.org. The EU directive can be accessed by the following website: http://europa.eu.int/eur-lex/en/ or http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_177/l_17720020706en00130019.pdf. The following tables can be used as a guidance when measuring vibration.

ISO standard	Measurement
Hand-Arm Vibration	5 Hz to 1500 Hz

Table 1-1: HAV Threshold levels defined by ISO 5349

Total daily exposure duration	Max Frequency-weighted RMS X_h, Y_h, or Z_h where the ***dominant RMS axis value*** shall not exceed the following:
4 hours and less than 8 hours	4 m/s^2
2 hours and less than 4 hours	6 m/s^2
1 hour and less than	8 m/s^2
Less than an hour	12m/s^2

Table 1-2: ANSI S3.34 standard for Total Aeq Duration Limits.

The following standard is based on the dominant weighted RMS value of the three axes. This standard requires weighted vibration measurement and filter analysis (or spectrum analysis) of each axis to determine daily exposure.

EU directive defines daily exposure action and limit values	Measurement value is based on 8-hour intervals
Exposure Action Value (EAV)	2.5 m/s^2
Exposure Limit Value (ELV)	5.0 m/s^2

Table 1-3: EU directive 2002/44/EC standards for HAV
(Daily action and limit values based on 8-hour interval)

Direction of Measurement for WBV

Whole-body vibration (WBV) is a form of mechanical vibration transmitted through a supporting surface to the body such as a heavy equipment operator will detect vibration through the seat of the vehicle to his/her spine. The diagrams below indicate the direction of the axes for a person standing or sitting. The x-axis is through the body, the y-axis is across the body and the z-axis is up and down the body.

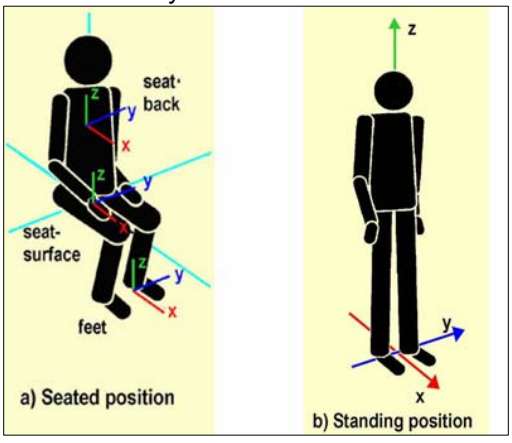


Figure 1-2: Defined direction of whole-body measurement

Threshold and exposure values for WBV

The following tables identify *Threshold Levels* which you can use as a guidance when determining the effects of whole body vibration.

ISO 2631 standard	Threshold Measurement
Whole Body Vibration	1 Hz to 80 Hz

Table 1-4: WBV Threshold levels defined by ISO 2631

ISO 2631 standard	Threshold Measurement
Z axis – (head to toe)	4 HZ to 8 HZ
X axis - (back to chest) and **Y axis -** (left to right)	1 HZ to 2 HZ
Whole-body vibration	1 HZ to 80 HZ

Table 1-5: ISO standards for WBV TLV's
TLV's are defined with 1/3 octave band filters and RMS value (according to ISO 2631, 2003)

EU directive defines daily exposure action and limit values	Measurement value is based on 8-hour intervals	Vibration Dose Value is based on 8-hour intervals
Exposure Action Value (EAV)	.5 m/s^2	9.1 $m/s^{1.75}$
Exposure Limit Value (ELV)	1.15 m/s^2	21 $m/s^{1.75}$

Table 1-6: EU directive 2002/44/EC standards for WBV
WBV daily action and limit values based on 8-hour interval

Exposure Assessment Steps

1. **Perform a task-based work flow analysis of exposure to hand-arm vibration, whole-body vibration, and/or noise.**
   - Observe areas of HAV and/or WBV in your environment.
   - Jot down areas of concern for human vibration and/or sound issues.
     - See chapter 1 for threshold and exposure guidelines.

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2. **Select tasks to be measured.**
   - Create a list of what you will be testing.

↓

3. **Setup VI-410 for your vibration testing.**
   - Customize user setup for hand-arm or whole-body testing.
     - See Chapter 3 for vibration testing set-up. See Chapter 8 for Sound testing setup.
     - See Chapter 9 to setup with QSP-II.

↓

4. **Measure acceleration rates of each task.**
   - Connect accelerometer , mounting device (for HAV only), and meter to tool/machine.
     - See Chapter 5 “Running Measurements”.
   - Run tests.
     - See Chapter 5 “Running Measurements”.

↓

5. **Analyze measurement results.**
   - View Time History data and/or Summary data.
     - See Chapter 9 to view measurements with QuestSuite Professional II.
     - See Chapter 6 to view measurements on the instrument.

↓

6. **Develop corrective actions.**
   - Engineering: redesign tools, changes in workstation.
   - Administrative: job sharing/rotations, redefinition of job functions, reduce duration from tool/equipment, and/or implement medical surveillance.

Understanding what data is stored

When you are running studies on human vibration and/or sound, three types of data are stored: Summary data, Time History data, and Frequency Analysis.

Summary data

Summary data computes the averages of the whole run. For instance, the summary of vibration dose value calculates the overall VDV value instead of reporting specific measurements that are time stamped.

Time history data

Time history data is also referred as “logged data” which plots measurement values in second by second, minute by minute, or hour by hour intervals (this is dependent on your settings). Generally, time history data will save selected measurements at fixed intervals during a study.

Frequency analysis and filters

With vibration, you may have a situation of measuring mechanical shocks with short durations. In order to understand the effects of this vibration, it is necessary to isolate the vibration and look at the frequency components.

By applying a frequency analysis filter, this will only pass parts of the vibration signal which are contained in a narrow frequency band. The pass band of the filter moves across the frequency range and computes a separate vibration reading for each band.

On the VI-410, there are three frequency analysis options: full octave (1/1) band filter, 1/3 octave band filter and Fast Fourier Transform (FFT) filter. In a 1/1 octave band filter, there are eleven octave bands across the instrument’s bandwidth. With a 1/3 octave band filter, there are thirty-three-octave bands across the instrument’s bandwidth (see Figure 1-3). With FFT, this has a full frequency spectrum.

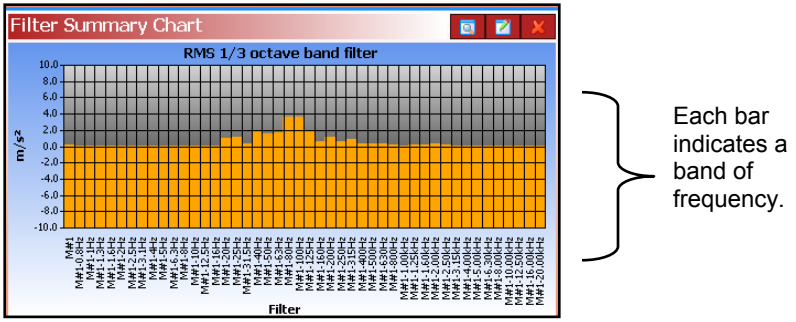

Figure 1-3: 1/3 octave band filter chart (in QSP-II only)

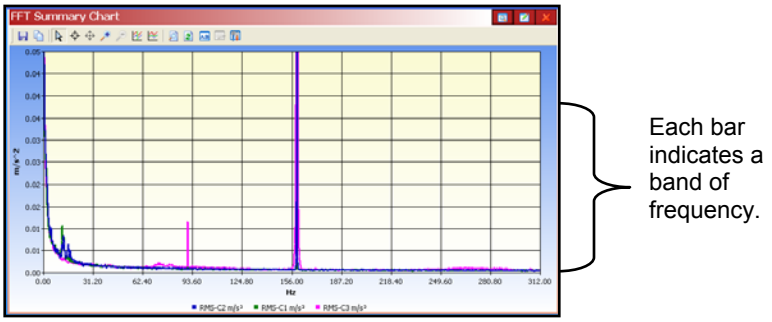

Figure 1-4: FFT band filter example (in QSP-II only)

QuestSuite Professional II

With the VI-410, you have the option of purchasing the QuestSuite Professional II software with the instrument. This manual will detail how to use QuestSuite Professional II software with the sound testing (see Chapter 9).

A Look at QuestSuite Professional II

With QuestSuite Professional II software (QSP-II), you can quickly, set-up the VI-410 with the appropriate mode, range, calibration, profile, filter, and logged items, retrieve the data from the instrument, view the measured results (also referred to as “files” on the instrument”), and print out customized reports from your pc.

In Figure 1-5, QSP-II is divided into two sections: My Instruments and Tree Nodes.

My Instruments

My Instruments enables you to manage multiple instruments in one program. This manual will focus on the Vibration family and specifically detail how to mange and use the VI-410.

In My Instruments you manage the following functions:

- Setup features and saving customized setups for your studies
- Store calibration certification information
- Set Data and Time on the instrument
- Retrieve data (or download data) from VI-410 to QuestSuite Professional II.

Tree Nodes

From the Tree Nodes, you can access your studies (which are labeled under the "**Downloaded**" node) and view your logged sessions in graphs and/or charts. This is also used to combine studies and export studies for file storage purposes.

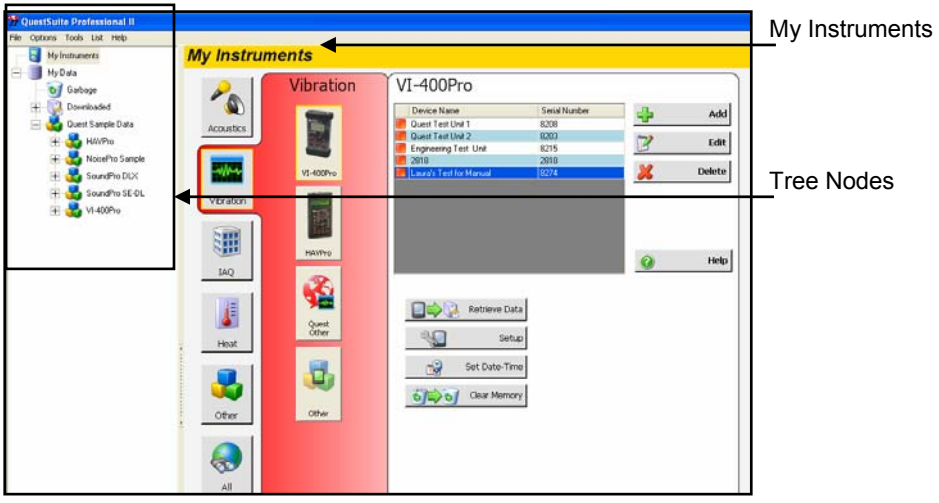

Figure 1-5: Explanation of Tree Nodes and My Instruments in QSP-II

Explanation of features in QSP-II

You will want to familiarize yourself with the main components of QSP-II. Below describes the sections in relation to taking vibration readings and for setup purposes.

My Instruments
Select a meter and then use it to retrieve data, setup parameters, and set date and time.

My Data
A section of the screen (called "pane") used to view your saved sessions.

Node
An expandable filing system in which you can access sub-nodes (i.e., downloaded node expanded out will show your logged data. in "VIB" folder)

VI-410
Select instrument in order to work with set-up, logged data, and retrieve data.

Meter Functionality
Retrieve Data, Setup, Clear Memory, and set Date-Time, etc.

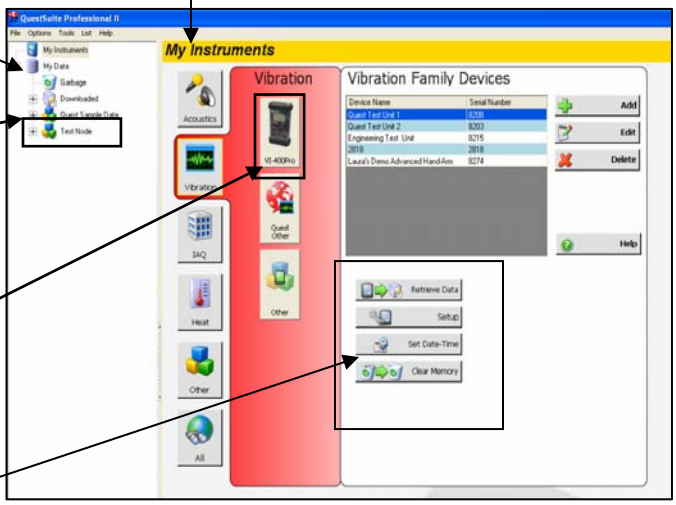

Figure 1-6: Displays the main log-on screen for Vibration in QSP-II software

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CHAPTER

2

Getting Started

This chapter provides a quick overview on getting started with the VI-410 and QSP-II software right out of the storage case.

Checking the equipment

If your instrument was sent to you in a storage case, you will want to remove all the packaging and acquaint yourself with the equipment so you can quickly get started with the human body vibration measurements. (Please see Figures 2-1 or 2-2 for examples.)

✍ ***NOTE:*** *Depending on the accessories you selected for hand-arm study or whole-body study, the VI-410 may have the following components. (Sound Level will be discussed in Chapter 8.)*

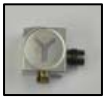
1. VI-410 advanced analyzer vibration meter.
2. Transducer (also called an accelerometer) and mounting device. (Three options depending if you are measuring HAV, WBV, and/or sound):
   a. Hand-Arm vibration accelerometer
   b. Whole-Body vibration accelerometer
   c. Microphone with preamplifier
3. USB computer interface cable.
4. IBM-compatible PC with USB Port.
5. QuestSuite Professional II (QSP II) Application software CD.

Equipment for hand arm study

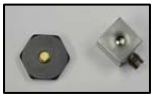
With hand arm studies, there are four types of mounting devices used to secure the accelerometer snuggly to a hand-held tool or mechanical machine which are:

(A) Clamp and mounting block

(B) Stud mounting



(C) Mounting pads



(D) T-handle

The diagram below displays equipment for HAV study.

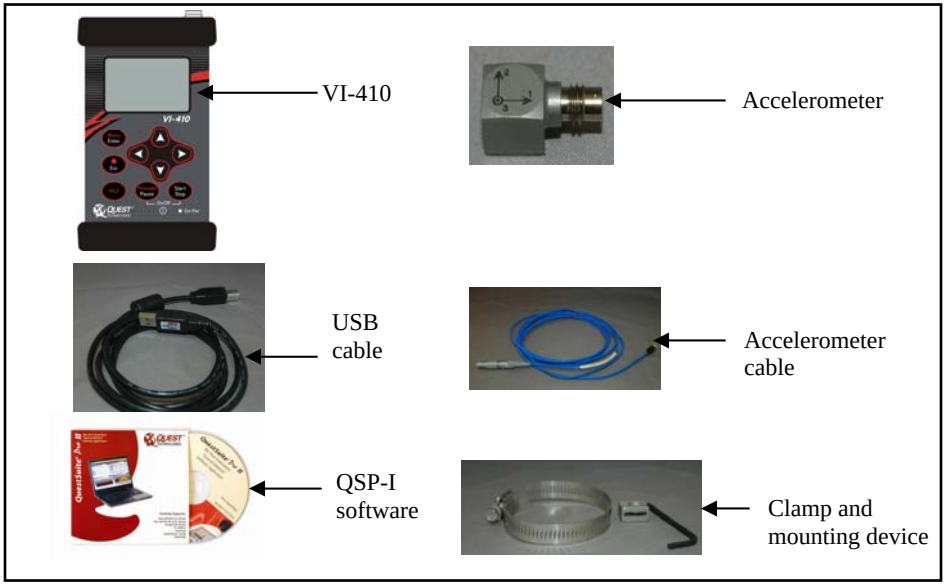


Figure 2-1: Example of equipment for HAV

Equipment for whole body study

With whole-body vibration study, there is one accelerometer used to measure the effects of vibration which is the seat-pad accelerometer. As explained in Chapter 6, the accelerometer is located in the middle and enclosed inside the disk shaped seat-pad object.

The diagram below displays equipment for a study using the mounting block and clamp to fasten the accelerometer to a hand-held tool.

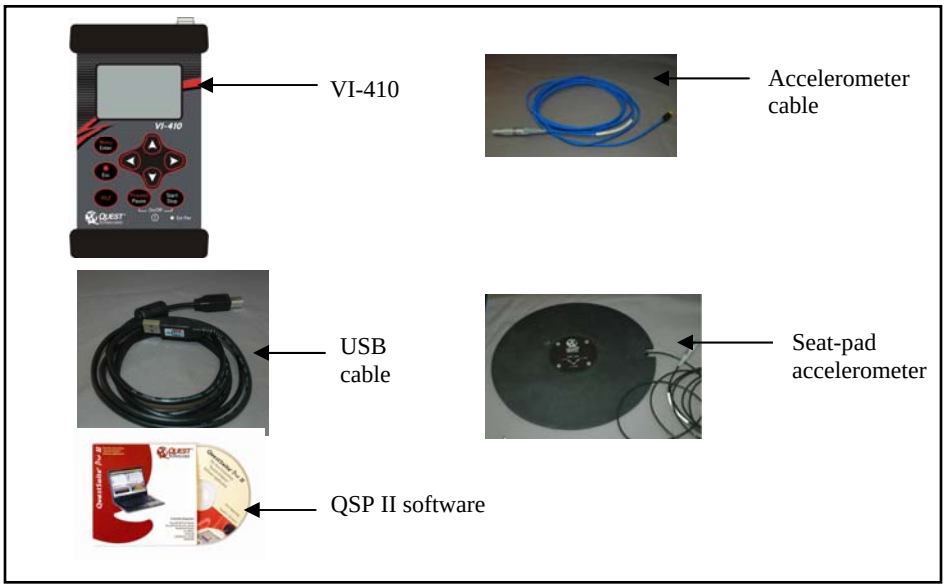


Figure 2-2: Example of equipment for WBV

Turning on the VI-410

The VI-410 is equipped to start, pause, resume, and stop. To turn on the instrument, simultaneously press Start Stop key and Proceed Pause key .

Warm up screen

The initial warm-up screen will display the name of the instrument and then a warm up screen will appear with a sixty second countdown. You can press the **Esc** key to view the start up screen immediately.

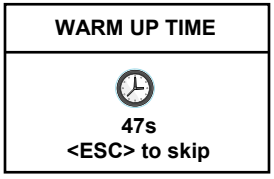


Figure 2-3: Warm up screen

Start-up screen components

The start-up screen displays a battery indicator and a 1-channel measurement screen. (No measurements are displayed at this point until you begin logging data), vertical scale (to the left of the screen), and the current time (called real-time clock).

✍ ***NOTE:*** *The start-up screen will display the previously viewed measurement screen from the last time you turned off the instrument which could be the 1-channel measurement screen, 4-channel measurement screen, statistics screen, or data logging screen (see the next section "Measurement views" for more information).*

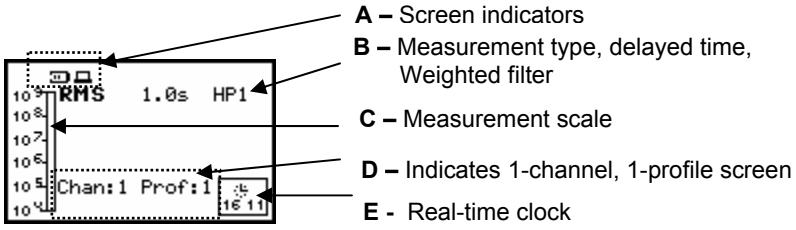


Figure 2-4: Start-up screen

Startup screen	Explanation
A. Battery and computer screen indicators	The **battery icon** indicates the amount of power to the instrument. Three bars indicate full battery supply. For more information on battery power, see section "checking battery power." The second indicator is a **computer indicator** which displays when the instrument is powered through the pc via USB cable.
B. Logged item, Response time, Weighted filter	**Logged item – RMS** (Root Mean Square) displays the measurement value calculated at RMS. **Response time – "1s"** indicates data is setup to log at one second intervals. **Weighted filter –** "HP1" is the applied filter for the vibration study. (This is explained in Chapters 3).
C. Measurement scale	A vertical scale representing the measurement results.
D. Channel-1/Profile-1 measurement screen	The one-channel measurement screen displays each channel's measurement's (and each profile if setup) results on individual screens. (NOTE: you can also view 4-channels on one screen as well.) The following measurement views are viewable in the one-channel screen (up to three different setups can be created for the x, y, and z axis): **C1P1 ~** default reference to the **X-Axis**. **C2P1 ~** default reference to **Y-Axis.** **C3P1 ~** default reference to **Z-Axis** **C4P1 ~** default reference to **sound mode** These channels can be customized during set-up. See Channel setup in Chapter 9 for QSP-II users or see Channel setup in Chapter 3 for VI-410 users.
E. Clock	The clock displays the current time. For information on changing the time, see Chapter 3, "real time clock".

Table 2-1: Startup screen defined

Display and keypad

The instrument's user interface consists of the display, the keypad, the selection keys, the connection ports at the top and the bottom of the instrument.

The display is used view menu options and measurement results. The **backlight** ☼ feature is used to illuminate the display in dark or hard to see environments. (The views, measurements, and icon indicators are explained in more detail in "Chapter 6, Taking Measurements").

The keypad has five dedicated keys which are color coded in red and white to distinguish between two different functions on one key. To activate the feature in the color red, you press the **Alt*f*** key first and then press the appropriate corresponding key. For example to access the menu for setup and viewing of file storage (etc.), simultaneously press **Menu/Enter** key and **Alt*f*** key. This enables the "menu" to appear on the VI-410 screen.

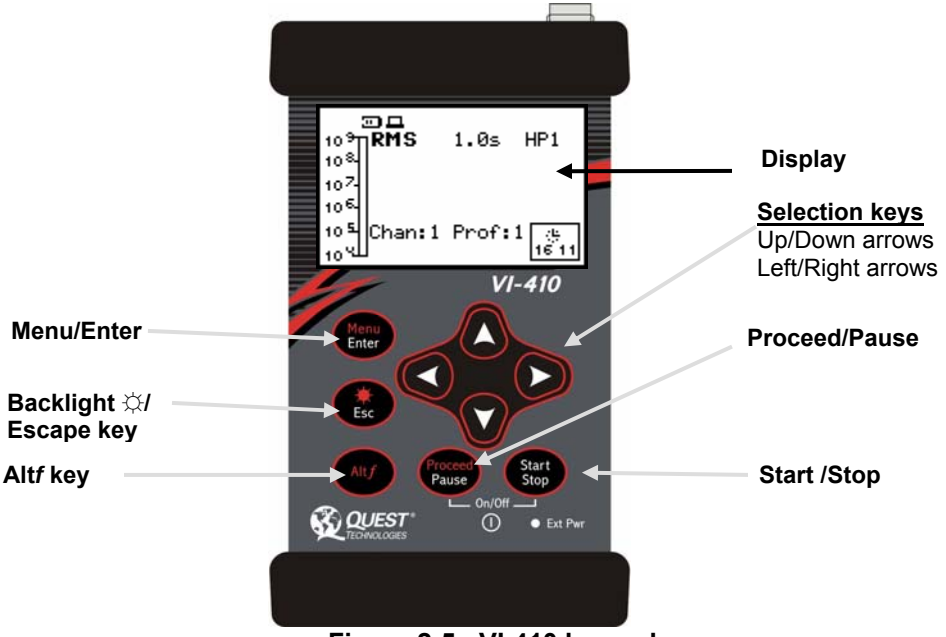


Figure 2-5: VI-410 keypad

Keypad functions	Explanation of keypad options
Menu Enter **Menu**	The **Menu** key enables you to access all of the menus and features in the main menu of the instrument. To select, simultaneously press the **Alt*f*** key and the **Menu** key.
Menu Enter **Enter**	The **Enter** key is used to select sub-menu lists, and/or change features in the sub-menus. (Please see "navigating through the menus" for more details.)
✸ Esc **Backlight**	The **Backlight** illuminates the display on the VI-410 and is used in dark environments. To illuminate the display screen, press **Alt*f*** + ☼ (backlight indicator icon).
✸ Esc **Escape**	Similar to an undo icon, **Escape** enables you to move back one level or "escapes" you out of your current sub-menus or elements.
Alt*f* **Alt*f***	The Alternative mode key has two functions:. **1.** **First function** of the **Alt*f*** key is similar to a Shift key on a pc keyboard. When pressing and holding **Alt*f*** , all features appearing in the color red on the keypad are accessible (I.e., Menu, ☼, and proceed). **2.** The **second function** of the **Alt*f*** is to move to the very top of a sub-menu list or move to the bottom of a sub-menu list.
Proceed Pause **Proceed**	Simultaneously pressing the **Proceed** key and the **Alt*f*** key enables the user to continue measuring human vibration and/or sound.
Proceed Pause **Pause**	**Pause** is used when you are recording human vibration and/or sound. You can take a sample reading (press **Start/Stop** key), pause the test (press **Pause** key), and start the test again when it is appropriate to take another measurement (press **Proceed** key +**Altf** key). ***Example:*** You are a safety control manager and you are taking measurements on vibration with your employee who is using a powered hand-tool. The worker sands the wood. (**Start/Stop** key). Turns off the tool (**Pause** key) and then turns it on again to sand another piece of wood (**Proceed** key +**Alt*f***). She/he finishes her/his sanding. (**Start/Stop** key).)
Start Stop **Start**	**Start** is used to start a logged session and/or power on the instrument. • ***To Power on the VI-410***, press and hold the **Start/Stop** key while pressing **Proceed/Pause** key.
Start Stop **Stop**	**Stop** is used to stop a logged session and/or power off the instrument. • ***To Stop recording***, press the **Start/Stop** key. • ***To Turn-off the VI410***, press and hold the **Pause** key while pressing the **Start/Stop** key.

Table 2-2: Keypad explanation

Navigating

The **up/down** keys and **right/left** keys are used to navigate through the menu options and modify menu settings and features on the instrument. The arrows are also used to select different measurement results as you are logging or viewing stored studies. (NOTE: the arrow images will be used to explain up/down or right/left procedures in this manual.)

Up/Down arrows

When viewing measurements, hold and press the ***Altf*** key and press either **up** or **down** arrow. This will toggle you through the X, Y, Z axes (denoted as Chan1, Chan2, Chan3) and Sound (default is set to Chan4 which is an add-on option).

Left/Right arrows

In the measurement screens, simultaneously press the **Alt*f*** key and right or left arrow, it will change the screen from a 1-channel measurement screen to a 4-channel measurement screen (For a detailed explanation, please refer to "4- channels measurement view" in Chapter 5.)

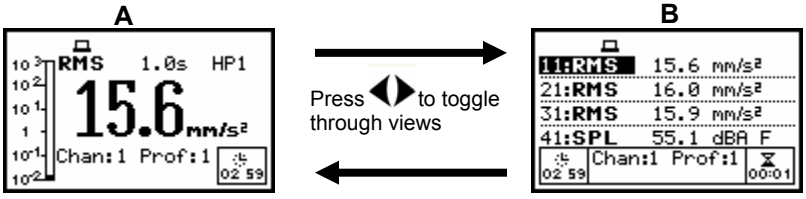


Figure 2-6: Left/Right arrows and Measurement screens

- ***Image A*** displays the RMS value of the X-axis (Channel 1 Profile 1) with HP1 weighted filter applied.
- ***Image B*** displays RMS values for X, Y, Z and sound channels in one screen denoted as "4-channel measurement view". with the RMS value. Image B displays 3 channel measurement views (Vector sum on Channel 1 or X-axis, RMS value on channel 2 or Y-axis, and RMS value on channel 3 or Z-axis) when toggling views by pressing **Alt*f*** and right arrow

Menu Navigation

Using the keypad keys and the arrows, you can quickly setup your study, run a study, and view results.

Figure 2-7: Turning on

➢ **Menu Navigation**

1. Turn on the instrument (simultaneously press **Proceed/Pause** key and the **Start/Stop** key).
2. Simultaneously press the **Alt*f*** key and the **Menu/Enter** key. (The main menu will be displayed.)
3. To select from the main menu, arrow ▲▼ accordingly and select a sub-menu feature.
4. Press **Menu/Enter** key to select a 2nd sub-menu.
   - Continue this process until you reach a screen to modify or view. To select a specific menu option, press ▲▼ arrows.
5. To change a feature ◀▶ arrow and press the **Menu/Enter** key to apply the changed feature and press Esc key repeatedly to return to main menu or measurement screen.

✍ ***NOTE:*** *if you want to move back one level, press the ☼/**ESC** key. Continue to press ☼/**ESC** key to move back up to the main menu if applicable.*

Connector inputs and outputs sockets

Inputs

On the top cover of the VI-410 are connecting inputs used for measurement purposes. The top left channel has a 4-pin Lemo connector which is used to record vibration from x, y, and z axes (Channels 1-3). (If you purchased the accelerometer cable and/or the seat-pad accelerometer, this cable is plugged into the left connector.)

The top right channel has a TNC connector and accepts input from a microphone preamplifier.

Lemo Channels 1-3
- Connect the instrument to the accelerometer for recording and measuring for HAV or WBV.

TNC Channel 4
- Connect the instrument to the preamp and microphone

Figure 2-8: Connector input sockets

Outputs

The meter has three bottom connectors: USB, AC/Int. and Ext. Power. Figure 1-9 illustrates the connectors and Table 1-9 defines the outputs.

AC/Int - The AC/Int has a dual purpose function:
An analog output with the signal from the input of the analog. This signal can be registered using a magnetic recorder.
The second purpose is a digital input for external input or digital output for external trigger.

USB - External connector used to connect the VI-410 to the QSP-II software/pc.

Ext. Power - The external power connector connects the external AC adapter (110V/230V) which furnishes the proper DC level. If external power connector is used, the instrument is powered from the DC source (from 6V to 24V).

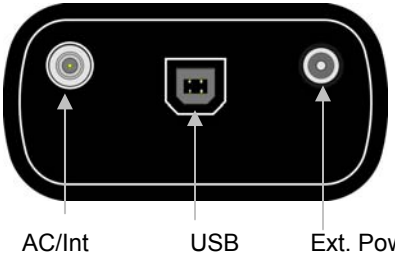


Figure 2-9: Defining output connectors

Checking battery power

It is a good practice to check the battery power before you begin logging/testing. The VI-410 uses four AA batteries, which will last for about eight hours as long as the backlight is not turned on. (This will decrease by 20% with the backlight illuminated.)
Other optional power options are four AA rechargeable batteries, USB power, or an external power battery pack (available as an add-on feature).

➢ **Checking the battery power via the battery indicator**

- In the start-up screen, a battery icon provides a visual display of the battery supply. If all three bars are shaded, the battery is at full power.

➢ ***Menu Path: Display>Power Supply***

1. Turn on the meter by pressing **Proceed/Pause** key and **Menu/Enter** key.

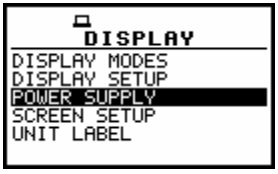


Figure 2-10: Power Supply menu

2. Select the menu path indicated above by selecting the following:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Arrow down to highlight **Display** menu and press **Menu/Enter** key.
   - Arrow down to highlight **Battery.** Press **Menu/Enter** key.
3. The Battery screen will display one of the battery power screens displayed in Figure 2-10. (This is dependent on how your instrument is powered.)

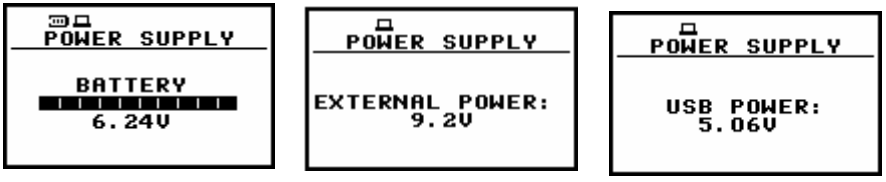
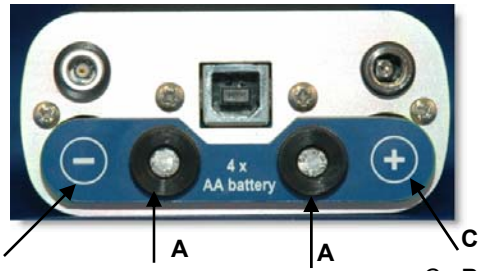


Figure 2-11: Power Supply screens

4. Press **Menu/Enter** key to save and press **Esc** repeatedly to return to the main menu or the measurement screen.

Installing the batteries

With the back of the instrument in your hand, pull the bottom black casing off of the instrument. Unscrew the two black knurled nuts and load the batteries as displayed in Figure 2-12.



B. **Battery location**
Load 2 x AA's with the negative side up

A. **Battery fasteners**
Unscrew to install batteries

C. **Battery location**
Load 2 x AA's with the positive side up

Figure 2-12: Illustration of installing batteries

Understanding Memory Storage

All available measurement results can be stored in the internal FLASH type memory of the instrument (32 MB). The capacity of the available memory is equal to 32 MB and is divided between logger (15 728 156 bytes) and results and setup settings (16 121 360 bytes).

The internal memory of the instrument is divided into two separate parts. One part is dedicated for saving the **results** and **setup** files and its size is equal to 16 121 360 bytes. The second part is used for saving the data logging files and its size is equal to 15 728 156 bytes. To save a **result file** the user has to choose either, **Auto Save** feature (see "Save Options" on page 37) or **Save Setup** (see "Saving your setups" on page 40).

CHAPTER

3

Setting-up the VI-410

This chapter covers the features and steps to setup the VI-410 via the instrument screens. (If you are using QSP-II, it is recommended to setup the instrument via the "Setup" key in the VI-410 family of instruments. Please see Chapter 9 for QSP-II details.)

☑ *TIP: if you would like to quickly move from the uppermost menu selection or the lowest menu selection in a list of options, press and hold either the up/down arrow and press the* ***Altf*** *key. It will shift the selector position to the highest or lowest selection in the menu.*

The following five bullet points detail how to customize your setup to ensure customized studies.

- **Customizing start-up features** – explains how to setup the real-time clock, screen contrast, and setting the backlight feature.
- **Working with Measurement setup** - describes the global features related to the start delay time, run time, and setting the log rate.
- **Working with the Channels setup**- discusses how to customize the mode, range, the response time, and the weighting for each axis (called "channel" on the instrument).
- **Working with Loggers setup** - a detailed look at how to select the appropriate measurements (i.e., rms), customize the measured results of x-axis (channel 1), y-axis (channel 2), and z-axis (channel 3)
- **Working with filters** - an explanation of setting the various analysis filters.
- **Setting Trigger mode** - an explanation and procedures for setting the triggering modes.
- **Working with the save setup features -** an explanation to save your setups, load setups, and how to save logged sessions.
- **Working with the advanced global settings -** an explanation of the advanced features on the VI-410 instrument.

Customizing your start-up features

During your initial start-up phase, you will want to set the "real time clock", adjust the contrast of the display to your environment, and learn how set the backlight.

Real time clock

The real time clock is positioned on the bottom right of the display of the instrument. It is used when you are running studies and recording the effects of human vibration and sound.

- ***Menu Path***: ***Setup>RTC>Real Time Clock screen***

1. In the on position, select the menu path indicated above by selecting the following:
2. Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼ arrows to highlight **Setup** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **RTC.** Press **Menu/Enter** key.
   - The RTC data screen appears (see Figure below).

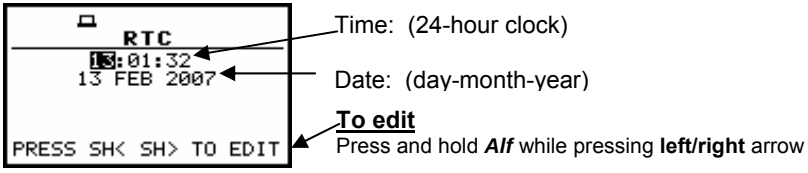


Figure 3-1: Real Time Clock (RTC) screen

3. To select and change **Time** fields, listed as **hours:minutes:seconds**, do one of the following:
   - Press ◀▶ arrows to select a field to change.
   - To change, press and hold **Alt*f*** while pressing ◀▶ arrows.
4. To select and change the **Date** fields, listed as day-month-year, do one of the following:
   - Press ◀▶ arrows to select a field to change.
   - To change, press and hold **Alt*f*** while pressing ◀▶ arrows.
5. Press **Menu/Enter** key to save and press **Esc** repeatedly to return to the main menu or the measurement screen.

Contrast and Backlight settings

The screen setup window enables the user to set a 30 second backlight automatic switch off , the brightness of the backlight and the proper contrast of the display.

With the Light Timeout feature, if you wish to save battery power, it is recommended to use the 30-second (Back) Light Timeout feature. A simple checkmark will activate this timer where as no checkmark indicates the backlight timer is deactivated. The backlight will activate each time you press the keypad proceeding each 30 second time out.

➢ ***Menu Path*: *Display>Screen setup***

1. In the on position, select the menu path indicated above by selecting the following:
   - Press ▲▼ arrows to highlight **Display** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Screen Setup.** Press **Menu/Enter** key.
2. In the Screen Setup press ▲▼ to select the **Light Timeout** field, **Brightness** field, or **Contrast** field.
3. To change the fields, press ◀▶ arrows.

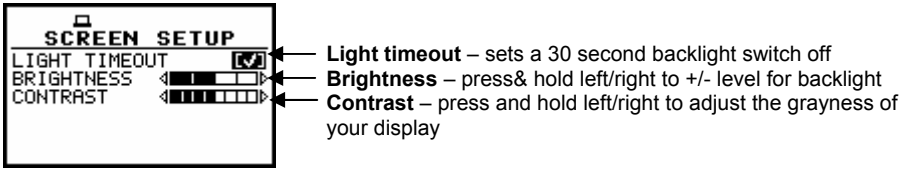


Figure 3-2: Backlight timer, backlight setting, and contrast setting

4. Press **Menu/Enter** key to save and press **Esc** repeatedly to return to the main menu or the measurement screen.

VI-410 information screen (meter unit)

To check the meter label or information screen for the name of the instrument, serial number (also posted on the back of the instrument) version and standards, you will want to visit the unit label screen.

➢ ***Menu Path*: *Display>Unit Label***

1. In the on position, select the menu path indicated above by selecting the following:
   - Press ▲▼ arrows to highlight **Display** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Unit Label.** Press **Menu/Enter** key.
2. To check view the information in the unit label screen, press ▲▼ arrows to scroll through the information.

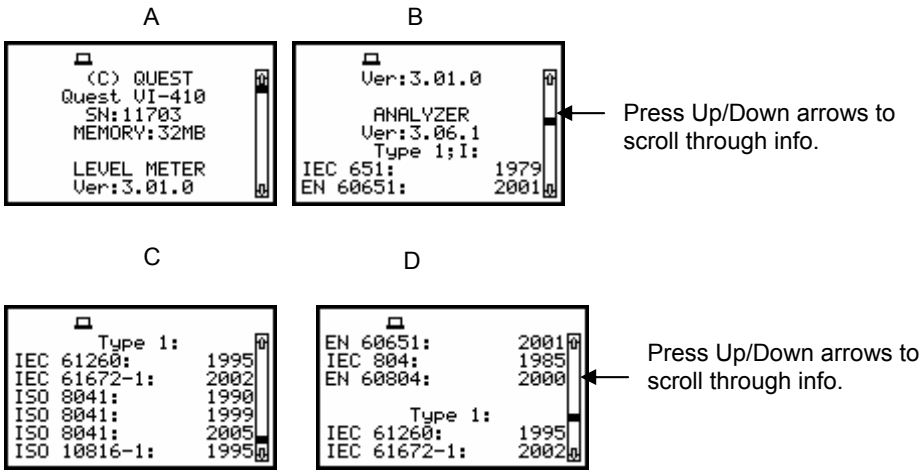


Figure 3-3: Information screen (serial & software #'s and standards)

Measurement setup features

On the VI-410, you can customize the overall settings by changing the following measure setup menu: start delay, integration time, repetition of measurement cycles, and buffer steps. The following sections outline how to change these settings. (These features are accessed from the Input menu and Measurement setup screen.)

✍ ***NOTE:*** *When changing the settings on this screen, ensure you press the Enter key when completed to activate your new settings.*

Start Delay

The start delay mode is used to define the time delay that will occur when the Start/Stop key is pressed until the start of your study occurs. The Start Delay is automatically set for 1 second and can be programmed up to a 60-second delay when enter is pressed after the field is changed.

Run Time/Integration period

The run time, also called integration period ("Int. Period") on the instrument, defines the period in which the signal is being averaged during the measurements. This can be changed from the 8-hour default to seconds, minutes, and various hour values.

✍ ***NOTE:*** *You can log various sessions at shorter intervals using the Start/Stop key and the Proceed/Pause key.*

Measurement cycles

You can define the number of measurement cycles (denoted as "Cycles Number") to be performed on the instrument which also coincides with the defined run time.

Log rate

The log rate (or called "Logger Step" on the instrument) will log and store measurement values every 1 minute (this is the default) until the study is paused or stopped. The log rate is set at various milliseconds, seconds, minutes, and one-hour values.

Measurement Setup

➢ ***Menu Path: Input>Measure Setup***

1. With the instrument turned on, select the menu path indicated above by selecting the following:
   - Press ▲▼ arrows to highlight **Input** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Measure Setup.** Press **Menu/Enter** key. (The Measurement setup screen will open.)
2. To select one of the fields, press ▲▼ arrows.
3. To change a field, press ◀▶ arrows.

✍ ***NOTE:*** *To move by increments of 10, press and hold the **Altf** while pressing ◀▶ arrows.*

4. To save any of the settings, press **Menu/Enter** key.

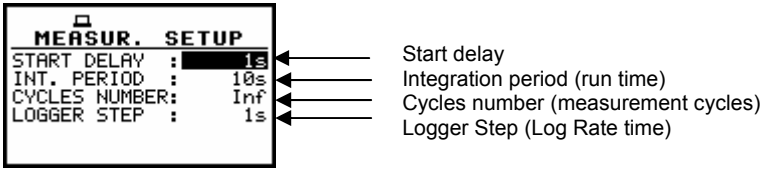


Figure 3-4: Measurement Setup

5. Press **Enter/Menu** key to save the changed setting. This will take you back one screen menu (to the Input menu). To return to the main screen, repeatedly press **Esc**.

Channel settings: mode, range, filter weighting, response time

The channel setup is used to set the appropriate vibration levels or sound level (for sound measurements please see Chapter 8). For human vibration measurements, the channel parameters include the mode, range, the weight filter, and response time (also called “detector” on the instrument). These features are accessed via the Input Menu and then selectable in the Channels Setup menu.

Mode (vibration or sound)

The selectable fields include either vibration or sound testing. In the case of vibration mode, the user selects the range, an optional weighted filter (**filter)** and response time (also called detector time constant**).**

In the case of sound mode, it is possible to set parameters for microphone (microphone correction) and to set parameters in profiles (PROFILE y).

Range

To measure acceleration, the range is determined by the following two ranges: 17.8 m/s2 or 316 m/s2

Filter

Frequency filters provide detailed results to identify the causes of vibration and enable you to develop corrective engineering and administrate changes. You have the following options:
wh- weighted filter for hand-arm studies.
HP - The following three types of high pass filters are used to measure acceleration.
HP1 (range 1HZ to 20 kHZ), HP3 (range 3.5 HZ to 20 kHZ), HP10 (range 10 HZ to 20 kHZ)
Velocity measurements -The following three types of digital filters are used to measure velocity:
Vel1, Vel10, VelMF
Displacement measurements - The following three types of digital filters are used to measure displacement.
Dil1, Dil3, Dil10
Human vibration measurements-The following are variations of digital filters to measure human vibration:
W-Bxy, W-Bz, H-A, W-Bc, KB, Wk, Wd, Wc, Wj

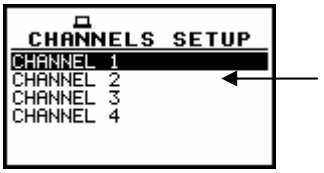
RMS Detector

The RMS detector can be set at the following intervals in the VLM mode: 100 ms, 125 ms, 200 ms, 500 ms, 1.0 s, 2.0 s, 5.0 s, and 10 s.

Changing channel settings

➢ ***Main Menu path:*** **Menu>Input>Channels Setup>Channel x**

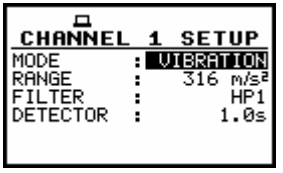
1. With the instrument turned on, select the menu path indicated above by selecting the following:
   - Press ▲▼ arrows to highlight **Input** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Channels Setup.** Press **Menu/Enter** key.



Channels 1-4
To setup each channel, select the first channel, make edits, and then return to this screen and select the subsequent channel until all channels are setup accordingly

Figure 3-5: Channels Setup screen

2. Select Channel 1, Channel 2, Channel 3, or Channel 4.
   - To select, press the ▲▼ arrows and then press **Menu/Ente**r key.
   - For example purposes, Channel 1 was selected as indicated in the next figure.
3. In the Channel 1 setup screen (or Channels 2-4 depending on your selection in step 2), press ▲▼ arrows to select one of the fields.
4. To change a field, press ◀▶ arrows.



Channel (1) Setup
- Vibration or Sound Mode
- Range
- Filter
- Detector (**response time**)

Figure 3-6: Measurement Setup

5. Press **Enter/Menu** key to save the changed settings. This will take you back one screen (Channels Setup screen).
6. To make changes on subsequent channels, please see steps 3-5 until all changes have been made.
7. Press **Esc** repeatedly to return to the main menu or the measurement screen.

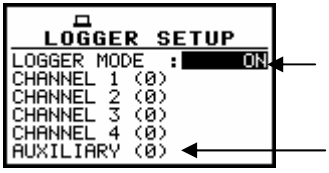
Saving Logged Items

Time history data

With the logger setup menu, you can save time history data which includes Peak, Peak-to-Peak (P-P), Maximum (MAX), RMS (similar to average vibration calculation), and Vibration Dose Value (VDV) measurements. Once selected, this data will store on the instrument. (See glossary of terms for explanation on measurements.).

➢ ***Main Menu path:*** **Input>Logger Setup>Logger Setup screen>select each channel**

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press ▲▼ arrows to highlight **Input** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Channels Setup.** Press **Menu/Enter** key.
2. To turn the logger setup on/off, press the arrow ◀▶ to select "**On**". If no text appears, this indicates Off.
   - Once in the On mode, Channels 1-4 and Auxiliary option will appear.
3. Select Channel 1, Channel 2, Channel 3, Channel 4, or Auxiliary, by using the ▲▼ arrows to select. Press **Menu/Enter** key to open the screen.



Logger Setup
To enable, press right/left arrow to switch to "On" mode

Auxiliary – Storing Vector and RPM settings

Figure 3-7: Logger Setup

4. In the Logger Setup (1) screen (or in the screen you selected in step 3) do one of the following:
   - Press **right or left arrow** to add a checkmark to the settings you wish to log. (A checkmark enables storing the logged item.)
   - To select a different field, press ▲▼ arrow until a specific field is selected.

- To Save your settings, press the **Menu/Enter** key. (It will return you to the previous Logger setup screen.) (Or press **Esc** key to undo your settings.)

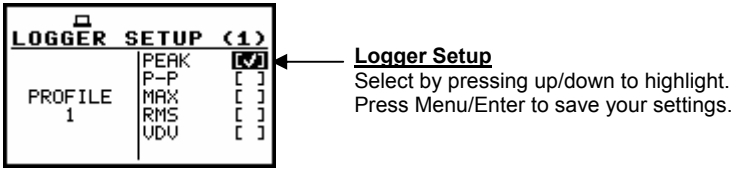


Figure 3-8: Logged item setup (i.e., Peak time history value saved)

5. To make changes on subsequent channels, please see steps 3-4 until all changes have been made.
6. To select either **Vector** or **RPM** measurement results, select the **Auxiliary** menu by pressing ▲▼ arrows and Menu/Enter key . Press ◀▶ arrows to check or uncheck.

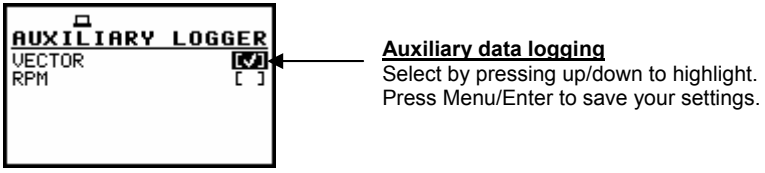


Figure 3-9: Enabling Vector or RPM logged settings

7. Press **Menu/Enter** key to save and press **Esc** key repeatedly to return to the main menu or the measurement screen.

Measurement Function

A Filtered frequency range captures specific data (noted as a “band” in the spectrum and attenuates (drops off) other measurements. This is typically used for engineering controls (See chapter 1, “Frequency Analysis” for more information.)

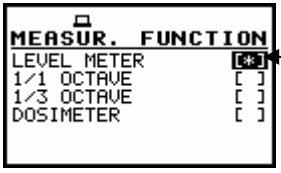
The default setting for the measurement function is set to “level meter” which indicates the filtered frequency analysis is not enabled. You have the option to enable as either full octave band (1/1) or 1/3 octave band. For sound, see Chapter 8.

Selecting 1/1 or 1/3 octave band analysis

➢ ***Menu Path: Function>Meas. Function >Measurement function screen***

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Press ▲▼ arrows to highlight **Function** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Measur. Function** and press **Menu/Enter** key.

2. To select a measurement function, press ▲▼ arrows to select one of the settings. Press ◀▶ arrow to select one of the options.



Asterisk indicates which mode is selected
Select by pressing up/down to highlight option.
Press right or left arrow to place a checkmark

Figure 3-10: 1/1 octave band, 1/3 octave, sound, or level meter

✍ ***NOTE:*** *When selecting either 1/1 or 1/3 octave band, an asterisk indicates if it is activated.*

3. Press **Menu/Enter** key to save the changed settings.

✍ ***NOTE:*** *If you set either 1/1 or 1/3 octave band analysis, this will now appear in the Input menu.*

4. Press **Esc** key repeatedly to return to the main menu or the measurement screen.

RMS data logging

Once 1/1 or 1/3 octave band analysis is selected as the measuring function, you have the option of activating RMS data logging. To activate this feature, ensure you followed the section above before beginning.

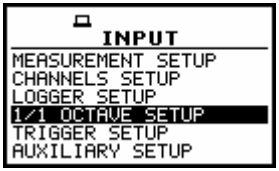


Figure 3-11: Selecting 1/1 octave setup

➢ ***Menu Path: Input>1/1 Octave Setup >Channel x (1-4)>Spectrum (x) (1-4)***

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu**/ **Enter** key.
   - Arrow ▲▼ to select **1/1 or 1/3 Octave Setup** and press **Menu**/**Enter** key.

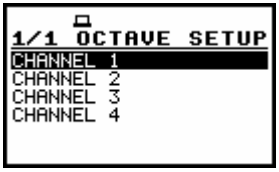
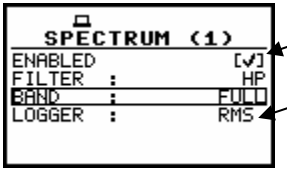


Figure 3-12: 1/1 octave setup and channel selection

2. To setup **RMS filter**, press Channel 1, Channel 2, Channel 3, or Channel 4 by pressing ▲▼ arrows and press **Menu/Enter** key.
3. To enable, press ◀▶ arrow in the Enabled field.
   - Press the down arrow to move to the **Logger** field.
   - To select **RMS**, press ◀▶ arrow until **RMS** appears.
   - To save this setting, press **Menu/Enter** key.
   - To return to the main screen, continue to press **Menu/Enter** or **Esc** key.



Spectrum (1)
Enabled: press left/right arrow to add checkmark

Logger: To activate RMS as a logged item, press right/left arrow when the cursor is on this field. (Press Menu/Enter to save)

Figure 3-13: Selecting RMS data item with 1/1 or 1/3 enabled

4. Press **Menu/Enter** key to save and press **Esc** repeatedly to return to the main menu or the measurement screen.

Save Options

There are three methods for saving your logged sessions. The ***first method*** is to save your files in the Logger Setup and choose which measurements to store as time history data (For more details, please see “Saving logged items”, on page 33.)

The ***second method***, and recommended for people who would like to view the sessions in QSP-II (such as a pc), is saving your files in the File main menu under Save submenu. Below explains how to Autosave and also explains the Save options on the VI-410.

The third method is to save each study as needed. For example, you would access the save menu and save each time before you run a study/measurements.

Setting Autosave, statistics, spectrum saving & replace

AutoSave

You can quickly turn on/off AutoSave on the instrument. This will save the measurement results as a file in the instruments memory (which is also referred to as “RAM file”). The default is set to “off”.

✍ ***NOTE:*** *When changing the AutoSave feature, you may get an error message stating that the integration period is too short. The “integration period” (or “run time” setting”) must be set to a minimum of 10-second run-time intervals. The default is set at 1-second intervals. (For more details on changing the run time or “integration period”, please see “Measurement Setup” on page 34.)*

Statistic saving

Additionally, in the Save options screen, you can save statistical data. Below explains how to enable these features.

RAM File

Saves data in a “RAM” file storage partition of the internal memory.

Spectrum saving: minimum and maximum

- **Minimum Spectrum –** This setting is used to save the lowest values of the instantaneous spectrum.
- **Maximum Spectrum** – This setting is used to save the highest values of the instantaneous spectrum.

✍ ***NOTE:*** *these settings are calculated with a 100-milliseconds period, which occurred during the Run Time (also referred to as "integration period" which is set by the following menu path: Menu>Input>Measurement Setup>Int. Period. For more information, please see "Measurement Setup", on page 38.*

Replace a file

If activated, the "replace" feature will automatically save and replace (or over-write) a file when the naming convention is the same for a saved file or a saved setup.

Saving measurements each run/stop session

With the save feature, you may wish to control when the measurements are saved and when they are not saved. To apply the save feature, first run a measurement/study. Then if you want to save the data, you would navigate to the File menu and select the Save menu. The file will store in the internal memory (See Appendix B for file formats) and can be loaded and viewed (See Chapter 6) on the VI-410 or in QSP-II software.

➢ ***Menu Path: File>Save***

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **File** and press **Menu/Enter** key.
   - Arrow ▲▼ to select **Save** and press **Menu**/**Enter** key.

File name
To customize the name, press up/down arrow to select an alpha or numeric character

Auto name: To assign the file name field, ensure the Auto name field is switched to "number" as the field category.

Figure 3-14: Save screen

2. To customize the **file name**, press ▲▼ arrows to select the file name field. Then, press ◀▶ to navigate to each character . Press either up or down arrow to change the file name character to a specific number or letter. Continue to press the right arrow to move through the file naming convention.
3. Once you have selected a customized file name, turn the auto name field to "**Number**". This will activate the file name you set in step 2. (Press down arrow to select the Auto Name field. Press right arrow until "number" appears.)
4. Press **Menu/Enter** key to save your changes. Repeatedly press **Esc** to return to the main menu or the measurement screen.

Save Options Screen

➢ **Menu Path: File>Save Options> AutoSave option**

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **File** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Save Options** menu and press **Menu/Enter** key.
2. In the **Save Options** screen, there are six selections (see page 41 for details).
3. To select a Save Option, press ▲▼ arrows to select one of the settings. Press ◀▶ arrow to select one of the options.

✍ ***NOTE:*** *AutoSave is enabled/activated when "Number" appears in this field. The other fields are selected/activated when an asterisk appears. With the AutoSave field, press Menu/Enter to turn on this feature and then see step 5.*

4. Press **Menu/Enter** key to save your settings.

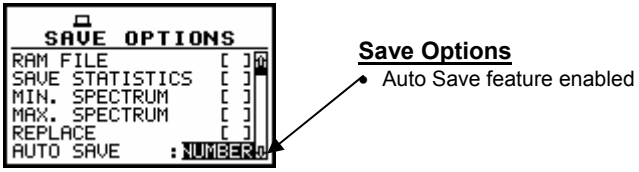


Figure 3-15: AutoSave enabled

5. If AutoSave is activated (and you pressed **Menu/Enter** key), an Auto File Name screen will appear.

   - **Optional:** type in a new file name by pressing **Up** or **Down** arrow. To move to the next field, press **Right** arrow. To add a space, press and hold **Alt*f*** while pressing the **right** arrow.

   - Press **Menu/Enter** to save changes.

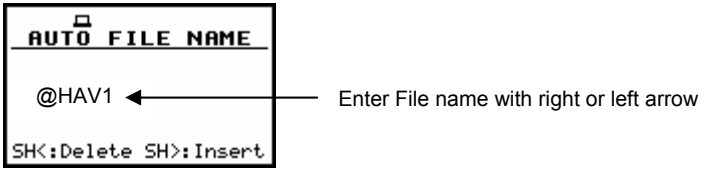


Figure 3-16: Auto File Name screen

6. Press **Esc** repeatedly to return to the main menu or the measurement screen.

Saving your Setups

With the VI-410, you can save one or multiple setups and assign each setup a custom file name. For example, you could create a setup for a Hand Arm Vibration test and create another setup for Whole Body Vibration test. Once set and saved, you would select and apply the setting via the "Load Setup" menu (explained in the proceeding section).

➢ ***Menu Path: File>Save Setup***

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **File** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Save Setup** menu and press **Menu/Enter** key.
2. To save the current setup, add a file name (or leave the default name) and select "**Number**" in the **Auto Name** field.
   - To add a file name, press ▲▼ **arrows**.
   - To move to the next field, press **left** or **right arrow**.
3. To change the **Auto Name field**, press ▲▼ arrows to select the field and press the **right** or **left arrow** to change the field to "Off" or "Number".

✍ ***NOTE:*** *In the Auto Name field, "Number" signifies that the instrument will save the setup with the designated file name displayed in the File Name field.*

Figure 3-17: Auto File Name screen

4. To save your changes, press **Menu/Enter** key. (If you do not wish to save your changes, press Esc key.)
5. To save the settings, press Menu/Enter key. Repeatedly press **Esc** key to return to the menu or measurement screen.

Saving filters

To enable or disable firmware filter options, you will want to visit the setup options screen.

➢ ***Menu Path: File>Setup Options***

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **File** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Setup Options** menu and press **Menu/Enter** key.
2. To save user filters, press the right arrow to add a checkmark. (To disable, press the right arrow again to uncheck.)

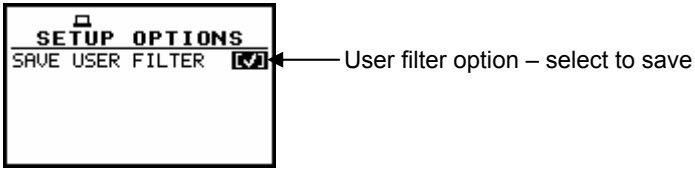


Figure 3-18: Save User Filter screen

3. To save the settings, press **Menu/Enter** key. Repeatedly press **Esc** key to return to the menu or measurement screen.

Working with Advanced settings

Setting up Auxiliary Devices

RPM/RPS Setup

RPM (or Revolutions per Minute) or to test **RPS** (Revolutions per Second) is most commonly used to measure rotational speed or angular velocity of a mechanical component with a tachometer. A Digital Input (or tachometer) is inserted in the bottom of the VI-410 in the I/O socket before the run is activated. (The digital I/O setup screen should be setup as "Digital In" as the mode. The menu path is as follows: Setup>Ext. I/O Setup.)
To Enable RPM/RPS, the end user will need a code (this is an additional option) before proceeding with setup and RPM measurements.

The screen fields/parameters are as follows:

- ***Pulses or Rotations*** - This feature enables the user to select the number of pulses / rotations during **RPM** measurement. The selectable values cover a range between**1** – **360** and are confirmed by pressing the **Menu/Enter** key.
- ***Unit*** – The unit enables you to select the measurement type as RPM or RPS (as defined above).
- ***Logger*** – The logger field enables you to save the results as data logging measurements or time history measurements.

✍ ***NOTE:*** *The following menu must be set to data logging: Input> Measurement Setup>Logger(For more information, please see "Saving logged items", on page 33).*

➢ ***Menu Path: Input>Auxiliary Setup>RPM Setup***

1. With the instrument turned on, select the menu path indicated above by selecting:
2. Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Auxiliary Setup** menu and press **Menu/Enter** key.
   - Arrow ▲▼ to **RPM Setup** menu and press **Menu/Enter** key.
3. To enable **RPM Setup**, press the **right arrow** to add checkmark in the enabled field.

✍ ***NOTE:*** *this may require an end-user code. Please call Quest's Technical Support for any questions.*

4. Press ▲▼ arrows to select one of the fields. To change the fields, press ◀▶ to select one of the options.

✍ ***NOTE:*** *For the Pulses/Rotation field, if you wish to move in increments of 10, press and hold* ***Altf*** *while pressing the* ***right*** *or* ***left arrow****.*

5. To save the settings, press **Menu/Enter** key. Repeatedly press **Esc** key to return to the main menu or measurement screen. When you run a study, the following results will display for one-measurement screens:

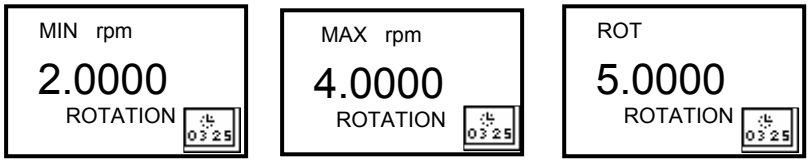


Figure 3-19: Save User Filter screen

SEAT setup for attenuation measurements

The seat setup option may be used for attenuation measurements of vibration. One of the channels (referred as a "**Base Channel**") measures the signal before attenuation and the other channel (referred to as a "**SEAT" Channel**) measures the signal after attenuation (i.e., as in the case of the seat suspension in vehicles).

➢ ***Menu Path: Input>Auxiliary Setup>"SEAT" Setup***

1. With the instrument turned on, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Auxiliary Setup** menu and press **Menu/Enter** key.
   - Arrow ▲▼ to **"Seat" Setup** menu and press **Menu/Enter** key.
2. To enable the **"SEAT" Setup** screen, press the **right arrow** to add checkmark in the enabled field.

3. For the "**SEAT" Channel** setup (measures after attenuation) and Base Channel setup (measures before attenuation), select a corresponding channel.

   - Press ▲▼ arrows to select **Seat Channel** field. Press ◀▶ arrow to select a specific channel. ***NOTE:*** *Remember with the default settings, Channel 1 corresponds with the x-axis, Channel 2 corresponds with the y-axis, and Channel 3 corresponds with the z-axis.*

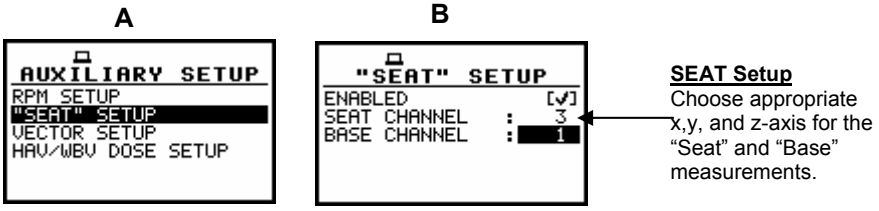


Figure 3-20: Auxiliary screen (A) and Seat Setup screen (B)

4. When you run a study (explained in Running Measurements- Chapter 5) the following results will appear:

   - The **"SEAT"** result is presented in one-measurement screen. It is calculated by dividing **RMS** result from the "Seat Channel" field by the RMS result from the "Base Channel" field.
   - Additionally, if VDV result is available for filters selected in Channels Setup screen, the SEAT result is calculated by dividing VDV result from "Seat Channel field" by VDV result from the "Base Channel" field.

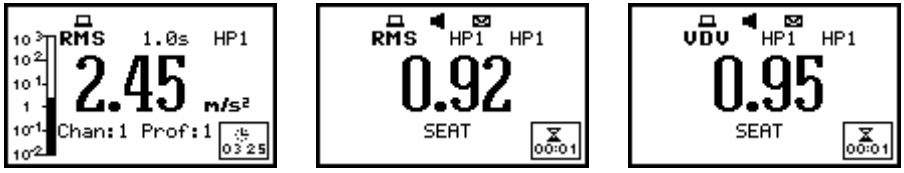


Figure 3-21: Results from "SEAT" measurements

Vector Setup

In the vector setup screen, the user may select the coefficients to calculate the vector. When the user needs to calculate it with other than standard coefficients, you can change the coefficient within the values from **0.00** to **2.00**.

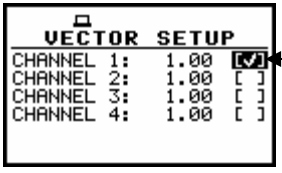
- The values presented below are taken into account during the calculations of the measurement results. **Vector is calculated with the following** formula:

$$\mathbf{VECTOR} = \sqrt{k_1 x_1^2 + k_2 x_2^2 + k_3 x_3^2 + k_4 x_4^2}$$

- Where k_1, k_2, k_3 and k_4 are the coefficients and x_1, x_2, x_3 and x_4 are RMS results for different channels. It is important that the user should choose only coefficients corresponding with the proper channels.

➢ ***Menu Path: Input>Auxiliary Setup>Vector Setup***

1. To modify vector calculations, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Auxiliary Setup** menu and press **Menu/Enter** key.
   - Arrow ▲▼ to **Vector Setup** menu and press **Menu/Enter** key.
2. To select a channel field press ▲▼ arrows. To change the value, press the right or left arrow to increase/decrease the vector coefficient.
3. To select a channel for computation purposes, press **Alt*f*** key to move to the bracket field. Press right arrow to enable (a checkmark indicates when it is enabled).
   - To disable, press right arrow until it is unchecked.



Vector Setup
- To select a vector measurement, select a specific channel and press Altf key to move to the brackets.
- Press right arrow to add a checkmark.

Figure 3-22: Vector Setup screen

HAV/WBV Dose Setup

With the Dose Setup screen, you have the following options:

- **Exposure Time** –enables the user to set the desired value of the exposure time that is used for the calculation HAV/WBV DOSE results. The selectable values range from one hour (00h01) to 24 hours (24h00).
- **X, Y, Z-Axis fields** – enables the user to edit the Channels 1-4 and filters if desired.
- **Standards field** – you have the option of applying standards from the following countries: United Kingdom, Italy, Poland, French, or a custom "User" standard.

➢ ***Menu Path: Input>Auxiliary Setup>HAV/WBV Dose Setup***

1. To modify HAV or WBV Dose setup, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Auxiliary Setup** menu and press **Menu/Enter** key.
   - Arrow ▲▼ to **HAV/WBV Dose Setup** menu and press **Menu/Enter** key.
2. To enable the **HAV or WBV Dose calculation**, add a checkmark to the "Enabled" field by pressing the right arrow. To select an alternative field, press the ▲▼ arrows.
3. To change the **Exposure Time**, press the right arrow to increase by increments of 1. To increase by increase of 10, press Altf and then press the right arrow repeatedly until the appropriate time value appears.
4. To move to the **axis settings**, press ▲▼ arrows. To change the channels, press the right arrow repeatedly until the appropriate channel is selected.

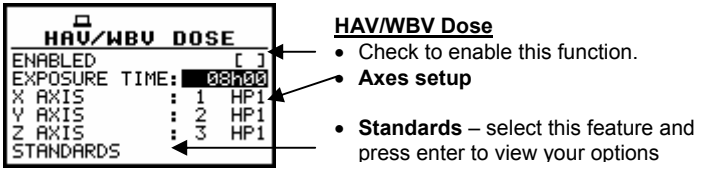


Figure 3-23: HAV/WBV Dose setup screen

5. To select the **Standards** field, press ▲▼ arrows and press **Menu/Enter** key. To page through and select a standard press ▲▼ arrows.
   - If you selected "User" and will be defining your own parameters. Press ◀▶ arrows to select a field. Press the right or left arrows to increase or decrease the numerical value.
6. To save the settings, press **Menu/Enter** key. Repeatedly press **Esc** key to return to the main menu or measurement screen.

Reference Level

A reference level for measurement signals can be set for acceleration, velocity, and displacement. The reference level is taken into account if measurement results are expressed in a logarithmic scale (with dB as the units).

Acceleration

The ***acceleration*** is defined as the rate of change with respect to time**.** (See "Glossary of Terms" for mathematical equation.) ***Acceleration*** reference can be adjusted from l to 100 μm/s^2.

Velocity

The ***velocity*** is defined as speed in one direction. (See "Glossary of Terms" for mathematical equation.) Velocity reference can be set from 1 nm/s to 100 nm/s[1].

Displacement

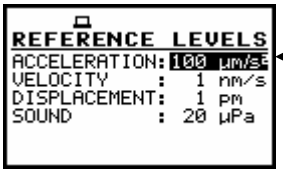
The ***displacement*** refers to the distance between the normal resting position of an object and its position at any given time in a vibration cycle. (See "Glossary of Terms" for mathematical equation.) Displacement can be set from 1 Pico meters (pm) to 100 Pico meters (pm).

➢ ***Menu path: Setup>Reference Levels***

1. To change or view the reference level, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Setup** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Reference Levels** menu and press **Menu/Enter** key.
2. In the **Reference Levels** screen, press the ▲▼ **arrows** to select Acceleration, Velocity, Displacement, or Sound.

3. To change one of the measurement signal values, press ◀▶ **arrow** until the appropriate value is selected.

✍ ***NOTE:*** *To increase or decrease the measurement value by increments of 10, press and hold Altf while pressing either the right arrow (increase) or left arrow (decrease).*



Acceleration - the default field is "1 µm/s^2. The field was changed by pressing and holding Altf and pressing right arrow repeatedly.

Figure 3-24: Selecting/Viewing reference level (acc., vel., or dis.)

4. To save your changes, press the **Menu/Enter** key. (You will be at the Setup screen.) Press **Esc** key repeatedly to return to the main menu or the measurement screen.

Setting input: Linear or Exponential

An input or detector type setting is used to select either RMS calculations using a linear integration method for vibration measurements or LEQ calculations using an exponential method for sound measurements.

➢ ***Menu path: Setup>RMS Integration***

1. To change or view the reference level, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Setup** and press **Menu/Enter** key.
   - Arrow ▲▼ to **RMS Integration** menu and press **Menu/Enter** key

2. In the **RMS Integration** screen, press the ▲▼ **arrows** to select Linear or Exponential. Press ◄► to add a checkmark in the **Linear** or **Exponential** fields (the checkmark denotes enabled or active mode).

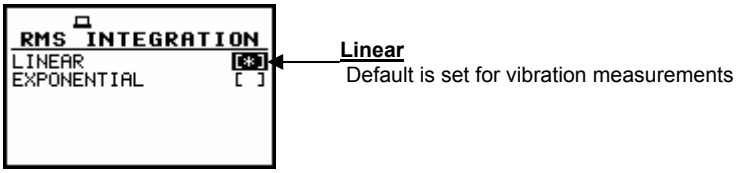


Figure 3-25: Selecting Linear or Exponential for Input/Detector Type

3. To save your changes, press the **Menu/Enter** key. (You will be at the Setup screen.) Press **Esc** key repeatedly to return to the main menu or the measurement screen.

Statistical levels

In the statistical levels screen, one can select ten statistics from one hundred calculated in the instrument which will in the same file with the measurement results.

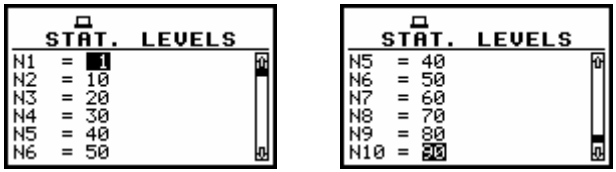


Figure 3-26: Viewing or selecting statistical levels

➢ ***Menu path: Setup>Statistical Levels***

1. To change or view the statistical levels, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Setup** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Statistical Levels** menu and press **Menu/Enter** key.
2. In the **Statistical Levels** screen, press the **right arrow** repeatedly to select a new level. To change other levels, press ▲▼ arrows.
3. To save your changes, press the **Menu/Enter** key. To return to the main screen or measurement screen, press **Esc** key repeatedly.

Filter coefficients for 1/1 and 1/3 octave analysis

User filter setup

Filter coefficients (or "weighting factor") can be modified for 1/1 or 1/3 octave band analysis measurements for vibration or sound studies. If you are applying filters in the band measurements, the measurement results will add these to the total values of the x, y, and z-axis.

Optional settings in the User Filters screen:

- **Mode field** – used to select either vibration or sound studies.
- **Filter field** – used to select specific axis or channel in order to view or apply coefficients. For example, for vibration channels one through three correspond with "vuser1, vuser2, and vuser3". For sound, "suser1, suser2, and suser3" are the corresponding channels.
- **View field** – used to view the octave band user filter coefficient settings (if applied).
- **Edit field–** to enable filter coefficients (or "weighting factors" as referenced in the ISO standards), this feature is selected and values are assigned by pressing the right/left arrows. (Please see sample screen below). The **range** is from **0.8 Hz to 20 kHz**.

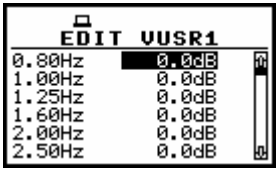


Figure 3-27: Viewing or selecting statistical levels

- **Clear field**– used to clear or delete any applied filters (set in the Edit field).

➢ ***Menu path: Setup>User Filters and coefficients***

1. To change or view **User Filters**, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Setup** and press **Menu/Enter** key.
   - Arrow ▲▼ to **User Filters** menu and press **Menu/Enter** key.

2. In the **Spectrum Based** screen, select the appropriate mode by pressing the **right arrow** to switch between vibration and sound.

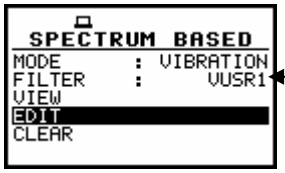


Figure 3-28: Applying filters for 1/1 or 1/3 measurements

3. Select a **Filter** for channel 1, channel 2, or channel 3 (corresponding with vuser 1, vuser2, vuser3) by pressing the down arrow until selected. Press **Right arrow** repeatedly to select the appropriate channel.
4. To edit or view the settings in this screen, press **Down arrow** repeatedly to select the **Edit** field and press **Menu/Enter** key.
5. To change the **Edit VUser1** screen, press ▲▼ arrow to select the appropriate field. Press ◀▶ repeatedly to select the appropriate filter coefficient.

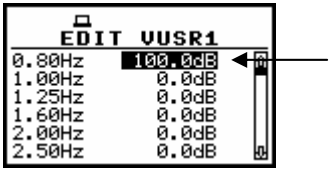


Figure 3-29: Viewing or selecting user filters

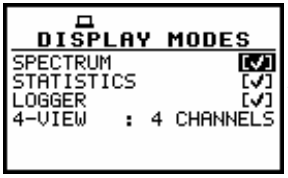
6. To save your changes, press the **Menu/Enter** key. To return to the main screen or measurement screen, press **Esc** key repeatedly.

Setting Display options

Customizing measurement results on the display

Before you begin logging data, you can set different displays to view on the instrument during your study. A One-Channel measurement view will always appear on the display during run mode. You have the following optional measurement screens to select: Spectrum (for 1/1 or 1/3 octave studies only), Statistics (for sound measurement testing), Logger (Time history data), and 4-view (4-channels on one screen).

1. From the main screen of the instrument, select the following menu options by using the **up/down arrows** to highlight and press **Menu/Enter key** to select: **Display>Display Mode> Display Mode screen.**

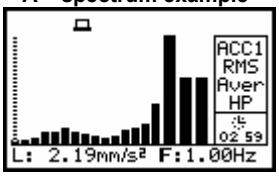


Display setup screen
Select measurement display modes to appear

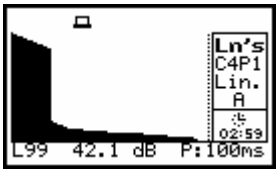
Figure 3-30: Defining what appears on the VI-410 screen during a vibration study

2. In the Display mode screen, you have the following four selections:

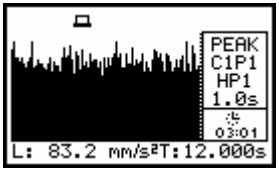
A – spectrum example



B – statistics example



C – logger example



D – 4-channel measurement view

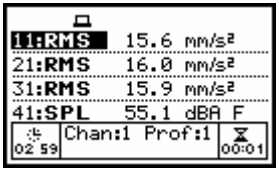


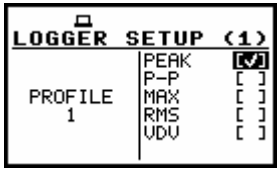
Figure 3-31: Setting Measurement results for VI-410

A. **Spectrum example** – this will appear if you activated 1/1 or 1/3 octave studies (Note: this is an additional feature.)

B. **Statistics example** – this will appear only with sound measurement testing.

C. **Logger example** – this will appear if the data from at least one channel/one profile is logged and stored in the logger file.

✍ ***NOTE:*** *If the logger position is switched on but there was nothing stored in the logger's file (when selecting logged items in the Logger Setup screen PEAK, P–P, MAX, RMS or VDV in the case of VM) then the VI-410 will display NO RESULTS. For more details on setting up these features, please see "Saving logged items", on page 33.*



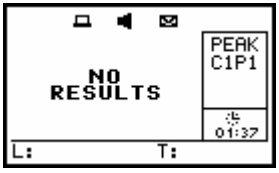


Figure 3-32: Logged items measurement screen – no results message

D. **4-channel measurement view** – Channels 1-4 (or x,y, z-axis and sound channel will appear all on one screen). To view each channels measurements, press and hold Altf while pressing right or left arrow. To move to an alternative channel (or axis), press and hold ***Altf*** while pressing **up/down arrow**. This will move you through the channel selections.

3. Press ▲▼ arrows to select one of the four display mode options and press ◀▶ arrow to activate (a checkmark appears) or de-activate (no checkmark).

4. Press **Menu/Enter** key to save the settings. Press **Esc** key until you return to the main screen.

Scale: changing graphical measurement results

As you are viewing vibration measurement results during run mode, the scale can be modified to a linear scale or a logarithm scale that displays the measurement results expressed in decibels. (The scale is applied to measurement results for time history data (from the logger menu) and spectra data (from the spectrum menu).) In this screen, you can also setting a zooming feature referred to as "X-Zoom". The **X–ZOOM** enables the user to change the horizontal axis in the **spectrum** measurement results.

✍ ***NOTE:*** *this feature only applies to vibration studies. To set vibration mode, please follow this menu path: Input>Channels Setup>Channel x, Mode (Mode field should display vibration). To change, please see section, "Changing channel settings", on page 32.*

➢ ***Menu path: Display >Display Setup> Display Scale***

1. To change or view the display channel for each channel, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Display** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Display Setup** menu and press **Menu/Enter** key.
2. Select **Channel 1, 2, 3, or 4** in the Display Setup screen.
   - Press ▲▼ to select a channel and press **Menu/Enter** key.
3. Press **Menu/Enter** key to select **Display Scale**.
4. For the Scale field, press ◀▶ to select either **Linear** (See "A") or **Logarithm** (See "B").

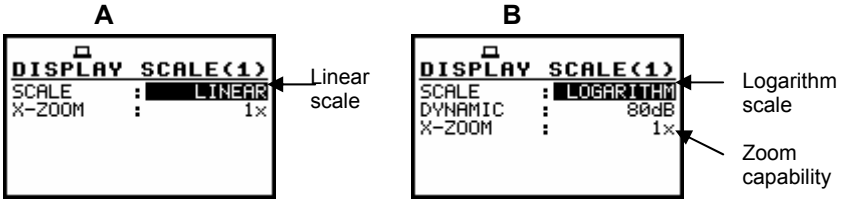


Figure 3-33: Viewing or selecting scale options

5. If you selected **Linear**, you have one optional field to modify. (Please skip to step 6 if you selected logarithm.)
   - To change the zooming function, press down arrow to select the field.
   - Press right arrow to increase the zoom and press the left arrow to decrease the zoom.

6. If you selected **Logarithm,** you have the following two options:
   - To change the dynamic (vertical axis) field, press the **down arrow** to select the field and press right or left arrow to select specific range. (In the case of the vertical axis field, the user can double, four times and eight times expansion (as the default the vertical axis corresponds to 80 dB, after expansion it corresponds to 40 dB, 20 dB and 10 dB – respectively.)
   - To change the x-zoon field, press the **down arrow** to select and press **right arrow** to select the appropriate value. (This feature enables the user to change the horizontal axis in the **SPECTRUM** presentation mode.)
7. To change the other channel settings, repeat steps 2-6 and then proceed to step 8.
8. To save your changes, press **Menu/Enter** key. To return to the main screen or measurement screen, press **Esc** key repeatedly.

✍ ***NOTE:*** *When you run a study, the following measurement scales will display for vibration mode.*

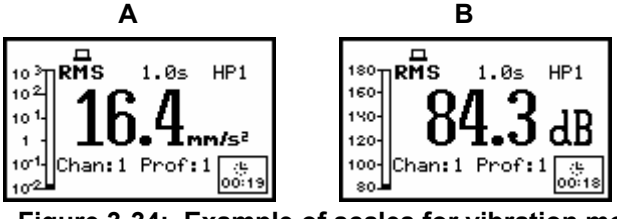


Figure 3-34: Example of scales for vibration mode

Spectrum parameters

For the spectrum display results, you can select vibration settings to appear as Averaged, Instantaneous, Maximum, or Minimum with either acceleration, velocity, or displacement as the type. For sound studies, RMS is the only selection and Averaged, Instantaneous, Maximum, or Minimum are the viewable selections. Below explains how to change the spectrum parameters.

➢ ***Menu path: Display >Display Setup> Select a channel>Spectrum View***

1. To change or view the display channel for each channel, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Display** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Display Setup** menu and press **Menu/Enter** key.
2. Select **Channel 1, 2, 3, or 4** in the Display Setup screen.

- Press ▲▼ to select a channel and press **Menu/Enter** key.

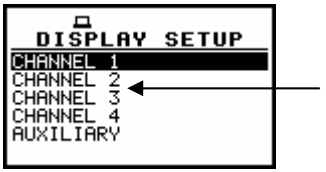


Figure 3-35: Display setup screen

3. Press ▲▼ **arrows** to select **Spectrum View** menu and press **Menu/Enter** key.

✍ ***NOTE:*** *if you selected channel 1, the screen will display "Spectrum View (1)". Thus, the menu will indicate which channel you selected proceeding Spectrum View.*

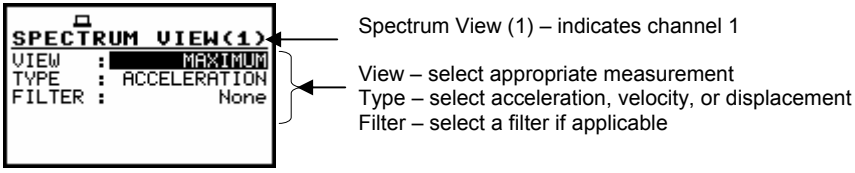


Figure 3-36: Spectrum channels screen

4. To change the **Spectrum View** screen, press one of the following:
   - To select a field, press ▲▼ arrows. To change the field, press ◀▶ arrow.

✍ ***NOTE:*** *for vibration or sound filters, you have the option of setting up to three profiles per channel. (denoted as "Vuser1" for vibration profile 1 results and "Suer1" for sound study profile 1 results.)*

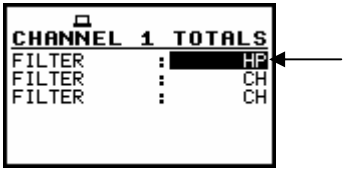
5. To change the other Channels' display, repeat steps 2 – 4 and then proceed to step 6.
6. To save your changes, press **Menu/Enter** key. To return to the main screen or measurement screen, press **Esc** key repeatedly.

Selecting weighted filters for total values calculation

To select weighted filters for the total values calculation, ensure that 1/1 or 1/3 octave band is selected before proceeding. (See "Selecting 1/1 or 1/3 Octave Band Analysis" on page 35 for details on activating.)

➢ ***Menu path: Display >Display Setup> select a channel>Total Values***

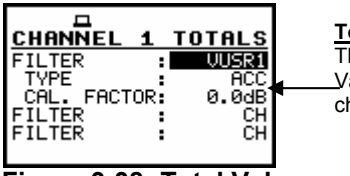
1. To change or view the **weighted filters**, turn the instrument on and select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Display** and press **Menu/Enter** key.
   - Arrow ▲▼ to **Display Setup** menu and press **Menu/Enter** key.
2. Select **Channel 1, 2, 3, or 4** in the Display Setup screen.
   - Press ▲▼ to select a channel and press **Menu/Enter** key.
3. Press ▲▼ arrows to select Total Values screen and press **Menu/Enter** key.
4. To change the filter settings, do one of the following:
   - Press ▲▼ arrows to select a Filter field.
   - Press ◀▶ to select a weighted filter.



Filter – select up to 3 filters per channel. (Also called 3 "profiles" per channel.)

Figure 3-37: Total Values channel filter screen

5. To apply a filter, Vuser 1, Vuser2, or Vuser3 can be selected by pressing the right arrow repeatedly or the left arrow.
6. To select a type, press the down arrow to select this field. Press the right or left arrows to select Acceleration, Velocity, or Displacement.
7. To add a calibration factor, press the up/down arrows to select the field and pres the right or left arrows to increase/decrease the value.



Total Values Display Setup
This indicates multiple **profiles** per channel where "Total Value 1" on channel 1 is the same as **X-axis** (if default of channel setup was not modified).

Figure 3-38: Total Values weighted filter screen

8. To change the other channel's weighted filters (for total values calculation), please repeat steps 2-4 and then proceed to step 6.
9. To save your changes, press **Menu/Enter** key. To return to the main screen or measurement screen, press **Esc** key repeatedly.

Trigger setup options

The trigger can be used to automatically start a study based on setting the "Slope+ or Slope-", "Level+ or Level-", "Logger", "Gradient", or "RTC" settings.

Note: *When activating the triggering mode for vibration level studies, the "triggering signal" is the signal coming from the RMS detector of the first channel.*

Slope+ or Slope-

When the ***Slope+*** mode is selected, the measurement starts when the signal increases past a specified **signal source** (i.e., vector value) and a specified vibration value (referred to as the "**level"** field). It will continue to store measurement values until the "run time" (also called integration time) is reached or if you manually stop the study. The default for the "run time" value is set at 8 hours.

When the ***Slope-*** mode is selected, the measurement starts when the signal decreases past a specified signal source and a specified vibration value and will continue to store measurement values until run time is reached or if you manually stop the study.

Level+ or Level-

When the **Level +** mode is set, the triggering condition is checked each second; the measurement is saved only when the signal is ***greater than*** the signal source level and in any other cases the measurement result is not stored.

When the **Level -** mode is set, the triggering condition is checked each second; the measurement is saved only when the signal is ***less than*** the signal source level and in any other cases the measurement result is not stored.

Logger

In the logger trigger mode, a pre and post logging rate is specified. If the logging rate is set at 15 second intervals for the pre and post intervals, for example, the instrument will look at all the measurements and store only the study time 15 seconds before and 15 seconds after the study.

Gradient

If **GRAD +** is selected, in each second of the measurement the triggering condition is checked; the measurement is registered only when the signal has the greater level than this determined in the **level** and the speed of the signal changes is not less than that selected in the **gradient**. In the other case the measurement result is skipped.

RTC

When Real Time Clock (RTC) is selected, the trigger condition is the time set in the real time clock screen (see “real time clock” on page 26 for more details.) The measurement is repeated when a time value is inputted in the RTC Step field. The number of repetition is equal to the cycle number. (The default setting is set to infinite. Please refer to menu path: Input>Measurement Setup>Cycle Number for more details.)

✍ ***NOTE:*** *Once the RTC triggers are setup, you must press the* ***Start/Stop*** *key and the measurement will be triggered on time selected in RTC START.*

Setting Trigger

➢ ***Menu path: Input>Trigger Setup> Trigger Setup screen***

1. To access the trigger screen, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Trigger setup** menu and press **Menu/Enter** key.
2. To activate the trigger setup screen, press the right arrow repeatedly until the appropriate Trigger field is selected. (For information on these fields see “Trigger setup options” above.)
3. Depending on your selection in step 2, please select one of the following and then see step 8. :
   - To setup Slope or Level triggers, please see step 4.
   - To setup Data Logging triggers, please see step 5.
   - To setup Gradient triggers, please see step 6.
   - To setup Real Time Clock triggers, please see step 7.

4. If **Slope or Level** is selected as the trigger field, you will want to select a **source**, a **channel**, **level**, and the **vector level**. To select one of the fields, press ▲▼ . To change the parameters in the fields, press repeatedly ◀▶ until one of the selections is chosen.

   - **Source field** – with the source field there are four options: RMS (1), Vector and Sound (VEC/SND), Vector, and EXT. IO (for Slope+/- only). (Please see "Glossary" for details.)
   - **Channel field** – select channel 1, 2, 3, or 4. (***NOTE:*** *if you did not change the default settings, Channels 1-4 correspond with x, y, and z-axes and channel 4 is setup for sound measurements.)*
   - **Level field –** depending on if you are selecting vibration or sound the level field is selectable as m/s^2 or dB. To increase in large increments, press and hold **Alt*f*** with either the **right or left arrow**. Or press right/left arrow to increase/decrease the value.

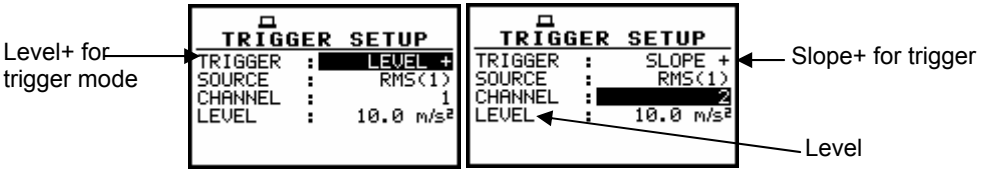


Figure 3-39: Level + and Slope+ for trigger modes

✍ ***NOTE:*** *The **Level** value (see Level field above) of the triggering signal refers to the instantaneous value of the RMS result from the first profile in selected channel calculated during the period depending on selected **"detector"** (also called "**response time**". Please refer to Changing channel settings on page 32.)*

5. If **Logger** is selected as the trigger field, you will want to select a **source**, a **channel**, **level**, and pre/post settings (if applicable). To select one of the fields, press ▲▼ . To change the parameters in the fields, press ◀▶ repeatedly until one of the selections is chosen.

   - **Source field** – with the source field there are four options: RMS (1), Vector and Sound (VEC/SND), Vector, and an HZ value. (Please see "Glossary" for details.)
   - **Channel field** – select channel 1, 2, 3, or 4
   - **Level field**– to increase/decrease level field, press **right or left arrow**. To **increase/decrease** in large increments, press and hold ***Altf*** while pressing the **right/left arrow**.

- **Pre/Post fields** – with the "**pre" field**, the number of the results saved in the logger's file before the fulfillment of the triggering condition can be set with a numeric value. With the "**post" field**, the user can set the number of the results registered in the logger's file after the fulfillment of the triggering condition.

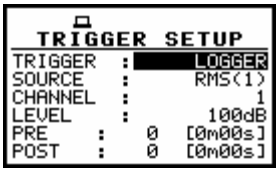


Figure 3-40: Logger trigger mode

6. If **Gradient** is selected as the trigger field, you will want to select a **source**, a **channel**, **level**, and a gradient value. To select one of the fields, press ▲▼ To change the parameters in the fields, press ◀▶ repeatedly until one of the selections is chosen.

   - **Source field** – with the source field there are four options: RMS (1), Vector and Sound (VEC/SND), Vector, and an HZ value. (Please see "Glossary" for details.)
   - **Channel field** - select channel 1, 2, 3, or 4
   - **Level field**– to increase/decrease level field, press **right or left arrow**. To **increase/decrease** in large increments, press and hold ***Altf*** while pressing the **right or left arrow**.
   - **Gradient** – select a value for the gradient trigger.

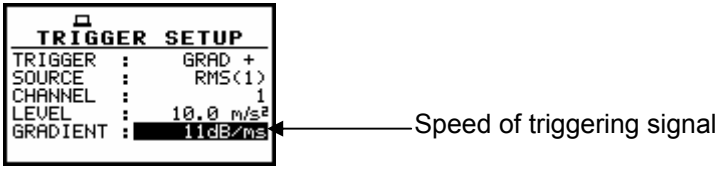


Figure 3-41: Logger trigger mode

7. Once **RTC** is selected as the trigger field, you will want to select a **RTC start time and the logging rate (called "RTC Step").** To select one of the fields, press ▲▼ . To change the parameters in the fields, press ◀▶ repeatedly until one of the selections is chosen. The confirmation of the selection requires pressing the **Enter** key, which simultaneously closes the sub-list. In order to activate waiting for trigger time the user has to press the **Start** key.

   - **RTC Start field**– select a start time based on the current time in the RTC of the instrument.

- **RTC Step**- select a data logging time based on the RTC of the instrument.

8. Once the trigger setup screen has been setup, press the Enter key to save your settings. Repeatedly press Esc to return to the main menu or measurement screen

Metric or non-metric settings

With the vibration units screen, you have the option of selecting metric (e.g. m/s^2, m/s, m etc.) or non-metric measurements (e.g. g, ips, mil etc.) for your studies.

➢ ***Menu path: Setup>Vibration units***

1. To access the vibration units screen, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Input** and press **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Vibration units** menu and press **Menu/Enter** key.

✍ ***NOTE:*** *in the vibration units screen, the asterisk indicates which field is selected. The default is "metric".*

2. To change the settings, press ▲▼ to highlight the field you wish to change. (For example, if you wish to set the VI-410 to non-metric, first select this field. Then press right arrow until an asterisk appears.)

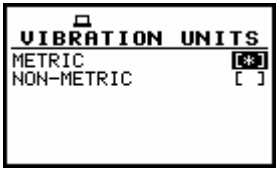


Figure 3-42: Metric/Non-Metric settings

3. Press ◀▶ to select either metric/non-metric field.
4. To save the changes, press the **Menu/Enter** key. To return to the main screen or measurement screen, repeatedly press **Esc** key.

Setting up external input/output connections

External I/O refers to external device connections. This feature enables a user to connect the VI-410 to another device. On this socket, the signal from the input or output of the analogue / digital converter (before the correction) is available. This signal can be registered using the magnetic recorder, can be observed on the oscilloscope or can be used for triggering measurements. It is possible to select three different modes: **Analog, Digital In, and Digital Out**.

➢ **Menu path: Setup>Ext. I/O Setup**

1. To access the External device connections screen, select the menu path indicated above by selecting:
   - Press and hold **Alt*f*** key while pressing **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Setup** and press **Menu/Enter** key.
   - Arrow ▲▼ to highlight **Ext. I/O Setup** menu and press **Menu/Enter** key.
2. There are three mode functions:
   - **Digital In -** The meter is connected to the output device, which triggers it. The measurements are started, when on this input there is a triggering impulse. In this mode the instrument works in **Ext. Triggers** function.
   - **Digital Out** - The meter is connected to the output device, which has to be triggered. In this mode the instrument works in **Trigger pulse** function (with **positive** or **negative polarization)** or **alarm pulse** function (with **low** or **high active level**). This mode is especially useful in the multi-channel, simultaneous, synchronized measurements.
   - **Analog** – In the Analog mode, the meter can send signals to the output device. For example, the signal can be observed on the oscilloscope from the selected **Channel**. The user has the opportunity to choose between **Channel 1, 2, 3, or 4**.

3. To change the Mode, Function, or Channel fields, press ▲▼ to highlight the field you wish to change. Then press the right arrow repeatedly until the appropriate value is displayed.

   - The figure below displays some of the output selections including digital output (A), digital input (B), and analog (C).

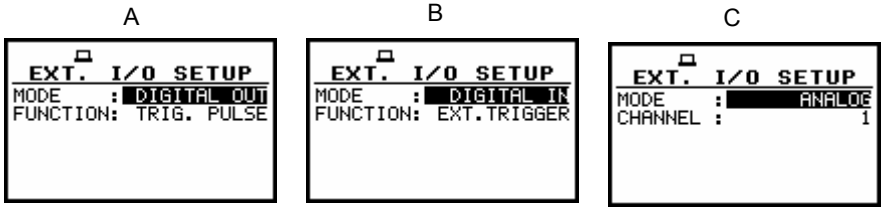


Figure 3-43: Logger trigger

4. To save your changes, press **Menu/Enter** key. To return to the main menu, press **Esc** continuously until you are at the menu screen or the measurement screen

Auto on features

The Auto on or "Timer" feature enables you to program the VI-410 to start a test on a specific day, a specific time, and with an optional repeat time feature. Below explains how to setup the parameters.

1. To access the main menu, press and hold ***Atlf*** and press **Menu/Enter** key.
2. Press ▲▼ arrows to select **Setup** and press **Menu/Enter** key.
3. Press ▲▼ arrows to select **Timer** and press **Menu/Enter** key. (The timer window will open.)
4. To set the fields, press ▲▼ arrows to select a field and press **right/left** arrows to change the value of the fields.
5. Press **Menu/Enter** key to save your setting. Press **Esc** repeatedly to return to the main menu.

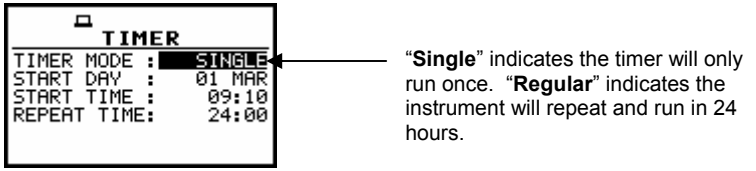


Figure 3-44: Auto on screen

✍ ***NOTE:*** *once activated, a flashing timer (or clock) icon will appear at the top of your screen.*

CHAPTER

4

Calibration

Before beginning your vibration or sound studies, a pre-calibration is recommended as well as a post-calibration on each channel following your study.

Why should you perform a pre and post calibration? The instrument can be affected by changes in altitude, barometric pressure, and humidity. Depending on where the VI-410 is stored and where you take the measurements, these factors can change the instrument's readings. When you are finished with your studies, it is important to quickly re-calibrate incase the instrument was mishandled or any changes in temperature, altitude, or barometric pressure changed.

For human vibration studies, you calibrate each channel in the field with a calibrated vibration source. An optional hand-held shaker calibrator may be included in your start-up kit. This calibrator will be explained in the "conducting a vibration calibration" section.

For sound studies, a sound calibrator is used to detect a fixed frequency and sound level. An explanation and diagram will detail how to perform a pre a post sound calibrator test in "conducting a sound calibration" section.

Performing a field vibration calibration

On the VI-410, there are two methods to calibrate.

- ***By measurement*** - this entails connecting a calibrator to the VI-410 and turning it on for the output to stabilize. Once the desired frequency and amplitude has been reached, this is entered into the meter (or in QSP-II).
- ***By sensitivity*** - the process of verifying the instrument's calibrated measurement indicated on the instrument's certification papers. (Typically, the instrument is calibrated before it is shipped.)

Conducting a vibration calibration for VLM

On a handheld Shaker Calibrator, this produces a known vibration acceleration rate and frequency. By connecting the accelerometer to the calibrator and then to the VI-410, you can verify and adjust calibration while you are in the field. Each channel (or axis) should be calibrated in order to meet the appropriate standards.

Assembly for Channel 3 (or Z axis)

1. Attach the accelerometer to the calibrator. Ensure the threaded pin is inserted into the calibrator first before attaching this to the accelerometer.

Attach the accelerometer to the calibrator by twisting it on until it fits snuggly.

Figure 4-1: Attaching accelerometer to calibrator

2. Attach the accelerometer cable to the accelerometer and then to the instrument.

Figure 4-2: Attaching accelerometer cable to instrument

Assembly for Channels 1-2 (or X and Y axes)

The steps are similar to calibrating the z-axis; however, instead of threading the accelerometer on the top of the shaker, the threaded screw on top of the calibrator is removed. A small piece of beeswax is then positioned firmly in its place. The accelerometer is positioned in accordance with ISO standards for the X and Y axis (as displayed in Figure 4-3) in relation to the calibrator. Then, the cable is connected to the accelerometer.

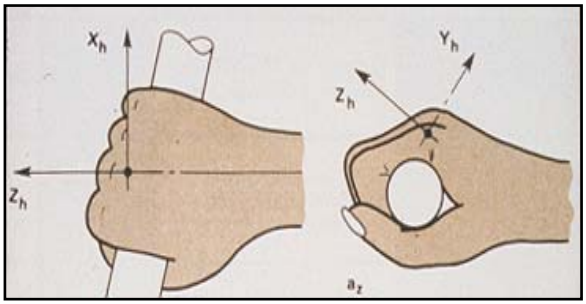


Figure 4-3: HAV vector coordinates in accordance with ISO standards

Running a vibration calibration

Once you have assembled the devices together you are ready to run a calibration test.

➢ ***Menu path:*** **Function>Calibration> >Channel 1, 2, 3, or 4 >By Measurement>Calibration**

1. Connect the calibrator and accelerometer to the VI-410 (as explained above in "**Conducting a vibration calibration**").
2. Turn on the VI-410 by pressing **Proceed/Pause** key and **Menu/Enter** key.
3. Select the following menu path:
   - Press **Alt*f*** key while pressing **Menu/Enter** key to access main menu.
   - The **Function** menu should be selected (if not press up/down arrow until selected). Next, press **Menu/Enter** key.
   - Arrow ▲▼ to **Calibration** sub-menu and press **Menu/Enter** key.
4. Arrow ▲▼ and select either channel 1, channel 2, or channel 3.
5. Arrow ▲▼ to **By Measurement** and press **Menu/Enter** key.
6. The calibrator level screen will appear (see Figure 4-4).
7. Adjust the **Calibrator level** screen to **9.89** (or the appropriate setting on your calibrator).
   - To adjust the cal level, press the **right arrow**. To move up by ten increments, simultaneously **press right** arrow and **Alt*f*** key.

Cal. Level (4)
Indicates you are calibrating for Channel 4.
Adjust the Cal. Level to 9.89m/s^2

Figure 4-4: Example of calibration screen for vibration study

8. **Turn on** the **calibrator**.
9. **Start the VI-410** by pressing **Start/Stop** key.
   - The meter will flash "**Calibration**" with a 5 second delay countdown, then "**Calibration Measure**", and then display "**Calibration Result**".
10. Once the **Calibration Result** is displayed, press the **Menu/Enter** key to store the new calibration level.

✍ ***NOTE:*** *the "Calibration result" is displayed as the RMS value for the channel you selected (such as channel 1).*

11. To calibrate each of the axes (or channels) for vibration study, press **Esc** twice until you return to the Channel selection screen and then repeat steps 4-10.
12. Once all channels are calibrated, press **Esc** key repeatedly to return to the main menu or the measurement menu.

✍ ***NOTE:*** *It is recommended to repeat the calibration measurement few times. The obtained results should be almost the same (with ±0.1 dB difference). The reasons for the unstable results are as follows: the calibrator is not properly attached to the instrument, there are external disturbances, or the calibrator or the measurement channel (the microphone, the preamplifier or the instrument itself) are damaged.*

Calibrating by certificate on VI-410

It is recommended to calibrate by taking measurement with a field calibrator for accurate onsite readings, which was discussed above in "Running a vibration calibration."

You also can send the VI-410 to Quest Technologies for factory calibration to ensure the instrument is setup correctly with the appropriate calibration.

Your third option is to calibrate the instrument by inputting values from the instrument's calibration card/certificate. This is completed by following the steps below.

➢ ***Main Menu path:*** **Function>Calibration>Channel X >By Sensitivity >Sensitivity screen**

1. Select the menu path indicated by following these steps:
   - To access the main menu, press ***Altf*** key while pressing **Menu/Enter** key.
   - Select **Function** menu by pressing ▲▼ and press **Menu/Enter** key.
   - Press ▲▼ and select **Calibration**. Press **Menu/Enter** key.
2. Press ▲▼ to select the appropriate **Channel** and press **Menu/Enter** key.
3. Press ▲▼ to select **By Sensitivity** and press **Menu/Enter** key.
4. In the Calibration sensitivity screen, you can manually input a calibration reading. Press the **left or right** arrows to increase or decrease the current measurement setting. Press the **Menu/Enter** key to save your new setting.

Figure 4-5: Calibration by sensitivity

5. Press **Esc** twice and select the next channel (i.e., channel 2). Repeat steps 2-4 until each channel is re- calibrated.
6. When complete, press **Esc** until you return to the main menu screen or measurement screen.

Calibrating by certificate using QSP-II

You can also adjust the calibration factor by entering in the appropriate "g" reading and plug this into QSP-II. Then, it will automatically calculate the calibration factor.

➢ **Adjusting calibration in QSP-II**

1. In QSP-II, ensure you are on the VI-410's window.
2. Select **Setup** key.
3. On each channel, modify or verify the appropriate setting (see Figure 4-5 for an explanation)

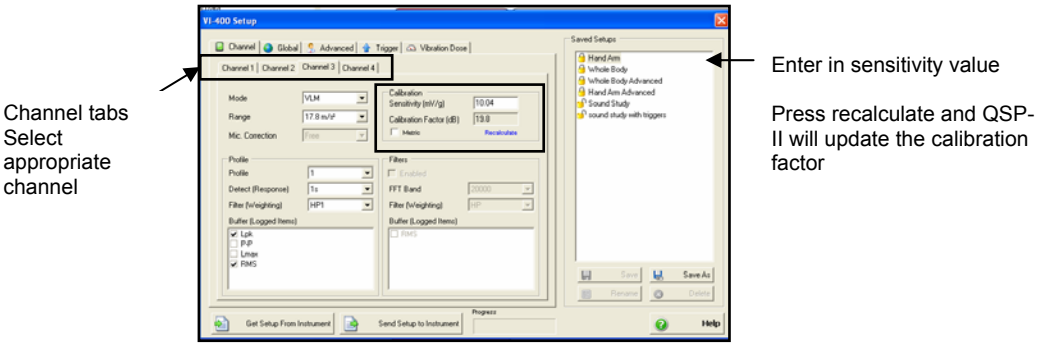


Figure 4-6: Example of setting calibration by sensitivity in QSP-II

4. To save, press **Save As** key and name the new setting.
5. To send to the instrument, ensure the VI-410 is connected via a USB cable to your pc. Press the "Send to Instrument" key.

Performing field calibration for sound

For a sound study, a pre and post calibration is recommended. To ensure that your microphone is functioning within normal tolerance limits, return it to the factory periodically for a factory recalibration.

This section explains to verify measurement calibration as part of your normal operating procedures.

Attaching calibrator for a sound study

The steps below outline how to attach a calibrator for a sound level study. For demonstration purposes, Quest Technologies Inc's QC10/20 Type 2 calibrator is used in the diagrams below.

1. Prepare the meter for a sound study.
    a. Ensure that channel 4 has been setup for sound (See "Setting up a sound study" in Chapter 8.)
    b. Attach the preamp and microphone to the VI-410 (See "Physical setup").

2. Taking the calibrator adapter, slide this into the top of the calibrator.

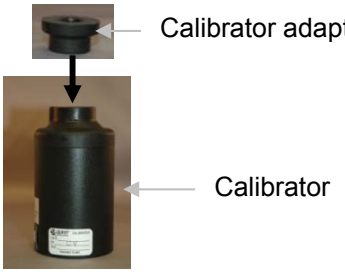


Figure 4-7: Connecting the calibrator and calibrator adapter

3. Next, taking the assembled calibrator, slide this into the microphone.

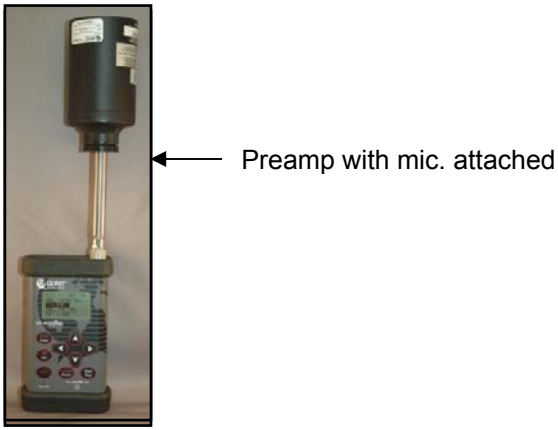


Figure 4-8: Attaching calibrator, preamp, and mic to VI-410

Running a sound calibration

➢ ***Menu path: Function>Calibration> >Channel x >By Measurement***

6. Attach the calibrator to the VI-410 (as illustrated above).
7. Select the menu path by:
   - To access the main menu, press ***Altf*** key while pressing **Menu/Enter** key.
   - Select **Function** menu by pressing ▲▼ and press **Menu/Enter** key.
   - Press ▲▼ and select **Calibration**. Press **Menu/Enter** key.
   - Press ▲▼ to select the Channel designated for sound (the default is Channel 1) and press **Menu/Enter** key.
   - Press ▲▼ to select **By Measurement** and press **Menu/Enter** key

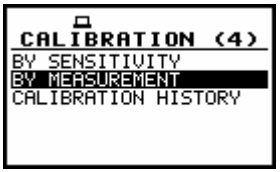


Figure 4-9: Calibration by Measurement for Channel 4

2. In the calibration level screen, adjust the **Calibrator level (4)** to **114db** (or the appropriate setting on your calibrator).
   - To adjust the cal level, press the right arrow. To move up by ten increments, simultaneously **press right** arrow and **Alt*f*** .

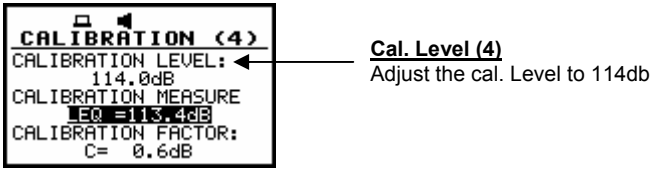


Figure 4-10: Example of calibration screen for sound study

3. **Turn on** the **calibrator**.
4. Start the VI-410 by pressing **Start/Stop** key.
   - The meter will flash "**Calibration**" with a 5-second delay countdown.
   - It will then flash "**Calibration Measure**" with a LEQ measurement and a value.
   - Once completed, it will display "**Calibration Result**" with a LEQ result value.
5. Once the calibration result is displayed, press the **Menu/Enter** key to store the new calibration level.
   a. ***NOTE:*** *the "Calibration result" is the calibrator factor in LEQ measurement value.*

6. To verify the calibration level, continue to press the escape key until you return to the main display.
   - If you are not on channel 4, press the up arrow until channel 4 is displayed.
7. Press the **start/sto**p key to run a study. The meter should be within ±0.1 dB difference of the calibrated level.

Viewing last calibration

Calibration History

In **calibration history screen, you** can view up to 10 last calibration records.

To access the calibration history screen, follow below:

➢ **Menu path: Function>Calibration> >Channel x >Calibration history**

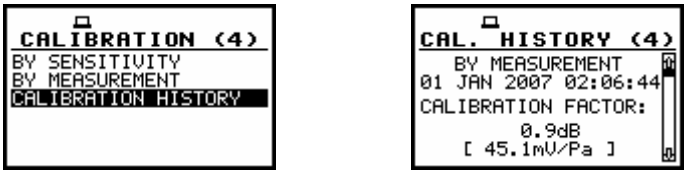


Figure 4-11: Calibration history screens

1. Select the Calibration history screen.
   - To access the main menu, press ***Altf*** key while pressing **Menu/Enter** key.
   - Select **Function** menu by pressing ▲▼ and press **Menu/Enter** key.
   - Press ▲▼ and select **Calibration**. Press **Menu/Enter** key.
   - Press ▲▼ to select the appropriate channel and press **Menu/Enter** key.
   - Press ▲▼ to select **By Calibration History** and press **Menu/Enter** key.
2. The opened Calibration history screen contains a list of last calibration records. Each calibration is described by the method of how it was performed either by sensitivity or by measurement. It includes the date and time of the performed calibration measurement, the obtained calibration factor, and the calibration result.

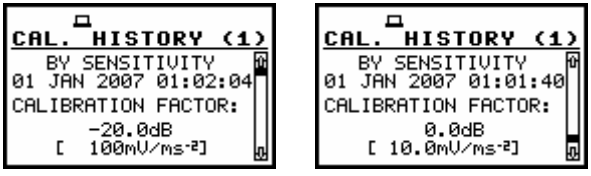


Figure 4-12: Calibration history with previous 2 cal. records

✍ ***NOTE:*** *if calibration measurements were not performed (such as channel 4 for sound studies), a calibration history screen appears stating "calibration history is empty".*

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CHAPTER

5

Running Measurements

Assuming you are acquainted with the VI-410's physical features (chapter 2), have customized your setup (see chapters 3) features, and calibrated your instrument (see chapter 4), you are now ready to run your measurements This chapter will explain placing the VI-410 in your environment, and then guide you through running and viewing your results.

- Overview of vibration and overview of taking measurements
- Understanding Measurement results - brief explanation of a one-measurement view, four-channel measurement view and an explanation of screen icons/indicators.
- A demonstration of hand-arm vibration study and a demonstration of whole-body vibration study
- How to mount and place the transducer (also called accelerometer) to the object/machine
- Steps on running a logging session
- Steps on how to run a study, pause a study, and run another study (trigger on/trigger off).

About Vibration

Vibration measurement is determined by the amplitude (or magnitude) of the source, frequency, and the duration and direction of the oscillating source. The Amplitude (or magnitude) is measured by a constantly changing weighted signal from the accelerometer to the vibration meter and it converts the logged data into an "average" value at a fixed frequency, typically once per second. This "average" is actually computed as the square root of the average (mean) of the squares of the vibration samples and is called **RMS**. According to the standards boards, such as ISO and ANSI, the RMS is a useful value because it demonstrates the overall vibration damage potential.

Taking Measurements

Depending on how the vibration is affecting the human body, this resonance frequency is analyzed in various measurements. **Peak-to-Peak** measurement and **Peak** measurements are also highly valued measurements. The figure below displays two types of human vibration. The **harmonic**, also called periodic, is vibration that is made up of continuous exposure elements. Random vibration does not repeat itself so in the case of a compactor on a construction site hitting pot holes in a dirt road, this would be an example of **random vibration**.

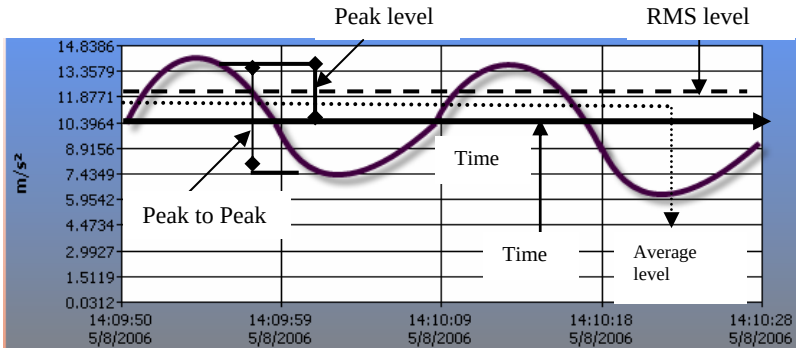


Figure 5-1: Harmonic vibration
Example of time history measurements: Peak level of vibration, Peak to Peak level, and RMS level which demonstrates the Average level and Time to calculate RMS level**.**

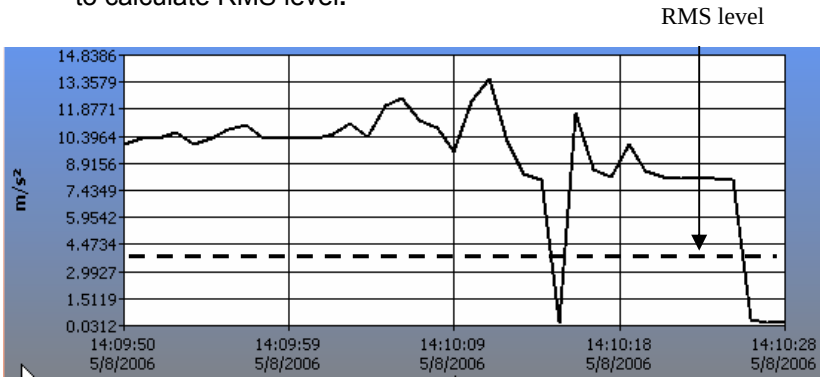
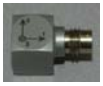


Figure 5-2: Random Vibration (from a circular saw study)
Illustrated is the RMS Level (3.86 m/s^2)

Demonstration of HAV study

Figure 5-3 demonstrates a hand arm vibration study. The VI-410 is connected with to a tranducer by a clamp mounting device as displayed below.

- Example of a Accelerometer 
- Example of clamp mounting device 

The tranducer (also referred to as an accelerometer) measures the acceleration rate of the vibration. When the study begins, the VI-410 is turned to the “Start” position and the hand-held tool is turned to the “On” position. The VI-410 will calculate and store the measurements from the worker using the drill. The type of measurements and filters are selected during the setup phase. While you are running your study, you can view the measurements on the VI-410 display screen. You can also use the up/down arrows and left/right arrows on the keypad to select different views. After the logged session, the results can be viewed on the instrument or uploaded to QuestSuite Professional II and viewed on your computer.

Figure 5-3: Example of how to conduct HAV study

Placement of accelerometer for HAV

In figure 5-3, notice the placement of the accelerometer to the clamping device. In order to gather accurate vibration readings, the accelerometer should be placed as close as possible to where the worker holds the tool without hindering his/her safety or interfering with his/her work. The accelerometer and mounting device should be tightened snugly to the tool; so, you obtain accurate readings when running your vibration session.

In chapter 1, we discussed the direction of measurement for HAV (see figure 1-1 for reference). As you are measuring vibration, ensure the accelerometer is placed in the appropriate direction in accordance with the ISO standards (see Figure 1-1).

Attaching the accelerometer for HAV study

Depending on which device you ordered, the mounting of the accelerometer is a couple easy steps.

Mounting block and hose clamp scenario

- **How to attach the accelerometer to the device for vibration study?**

1. Place the screw inside the mounting block.
2. Take the accelerometer (which has a female thread) and twist this into the screw (male thread) on the mounting block using the hex-driver tool (see illustration below)

Figure 5-4: Attaching mounting block to accelerometer

3. Slide the attached accelerometer with the mounting block onto the hose clamp. The beveled side must be turned toward inside of clamp so beveled side will clamp directly to the hand-held tool.

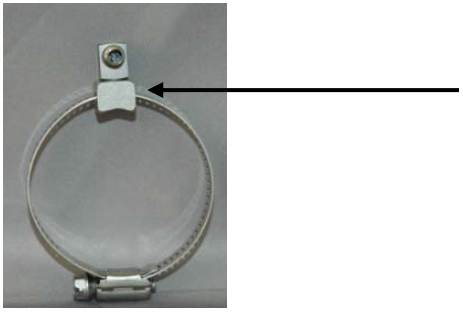


Figure 5-5: slide mounting block and accelerometer on hose clamp

4. Fasten the accelerometer oriented in accordance to the x, y, z-axis if you are concerned with engineering controls. If your study is for health and safety monitoring the standards prescribe the use vector sum on the dominant axis (which calculates the tri-axial average) and the orientation of the accelerometer is not of a concern.

5. Slide the clamp hose around the hand-held tool and securely tighten the screw with a screw driver.

Figure 5-6: Tighten hose clamp and accelerometer to tool

6. Attach the accelerometer cable to the VI-410 (ensure the red dot on the cable lines up with the red dot on the VI-410) and then to the hand-held tool.

Figure 5-7: Attach accelerometer cable to VI-410 then to accelerometer

- You are now ready to start taking measurements. (See section below "Start and stop your study" for more details.)

Demonstration WBV study

Figure 5-9 demonstrates a whole body vibration study inside an opeartors heavy equipment machine. In the cab, the VI-410 is connected to a seat-pad transducer which is displayed below.

❖ Example of a seat-pad accelerometer

Figure 5-8: Seat-pad accelerometer

The tranducer (also referred to as an accelerometer) measures the acceleration rate of the vibration. When the study begins, the VI-410 is turned to the "Start" position and the operator in the machine continues his/her normal operation of the heavy equipment machine. The VI-410 will calculate and store the vibration measurements while he/she is working. The type of measurements and filters are selected during the setup phase. After the logged session, the results can be viewed on the instrument or uploaded to QuestSuite Professional II and viewed on your computer.

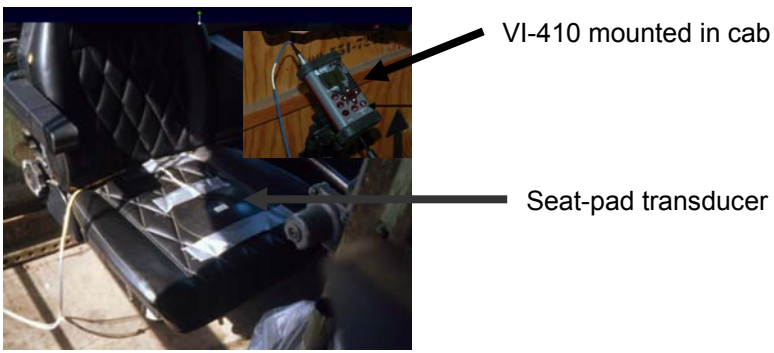


Figure 5-9: WBV example inside cab of heavy equipment machine

Placement of Transducer for WBV

In the middle of the seat-pad accelerometeter, a label indicates the x-axis, y-axis, and z-axis. The placement of the accelerometer should be placed parallel to the ISO standards defined in Chapter 1 as "direction of measurement for WBV", on page 5.

Attaching the accelerometer for WBV study

For Whole body vibration study, there are two quick steps to follow.

1. Place the seat-pad accelerometer on the seat. Ensure the positioning of the x-axis, y-axis, and z-axis is appropriate to ISO direction standards.

2. Plug the cable from the seat-pad into the VI-410. (Example: mount the VI-410 to something stable inside the machine.)
    a. You are now ready to start taking measurements.

Measuring

Start and Stop your study

By this point, you should have a good understanding of the setup features you programmed into the instrument as well as how to read the VI-410 during your study. The following details the couple of steps to start and stop your study.

➢ ***Starting and stopping***

1. Turn on the VI-410 by simultaneously pressing the **Proceed/Pause** key and **Start/Stop** key.
2. Press the **Start/Stop** key to enable the "run mode". The run indicator will appear along with a measurement value.

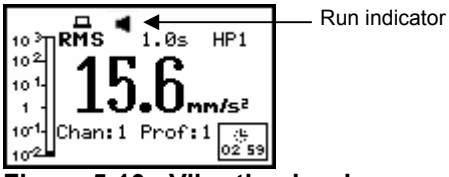


Figure 5-10: Vibration level run mode screen

    a. Press the **right/left arrows** to view various measurement results.
    b. Press the **up/down arrows** to view 4-channel measurement view.
    c. If you enabled spectrum and/or plot mode press the up/down arrow again, and these graphical views of the measurements will appear.
3. To stop your study, press the **Start/Stop** key again.
    a. You can now download (or export) the data to QSP-II or view the results on the VI-410. (See the Chapter 6 for details on viewing results on the VI-410 and Chapter 9 for details on QSP-II results.)

Start, Pause, and Stop your study

Some studies for human vibration are conducted by starting a study and then pausing while the hand-tool or machine is turned on or off. In these types of "trigger on" "trigger off" examples, the start and pause is used and saved as "studies" in QSP-II. If Start/Pause is pressed again and proceeded by a Stop, the summary of the Start to Stop data is stored as a "session" in QSP-II. Please see Chapter 9, "Downloading", for more details.

➢ **Using Pause mode during a study**

1. Turn on the VI-410 by simultaneously pressing the **Proceed/Pause** key and **Start/Stop** key.
2. Press the **Start/Stop** key to run the study.
3. To **Pause** your study, press the **Proceed/Pause** key. The **Run** indicator will flash in the pause mode. To resume, simultaneously press ***Altf*** and **Proceed/Pause** key.
4. To stop the study, press the **Start/Stop** key again. (It will state that it is saving the file.)

✍ ***NOTE:*** *You will want to run your study for at least the duration of your log rate time (this was selected during your setup. The default is set to one minute.) To view this setting in QSP-II, look under the Global tab in the Settings screen. The log rate field indicates your minimal time to log a vibration measurement.*

- On the VI-410, select to the following menu path: Input>Measure Setup> in the Measure setup screen. The "Logger" feature indicates the amount of time. (i.e., 1m indicates 1 minute).

Viewing measurement results

After you have stopped your data logging, the measurement results will automatically appear as your primary display.

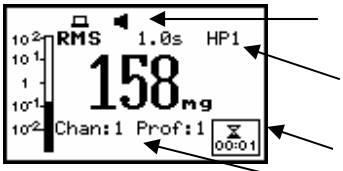
✍ ***NOTE:*** *depending on which displays you selected in Chapter 3, "Setting display options", on page 51, the following views may/may not appear.*

1-channel measurement view

One channel measurement view will automatically display as you are taking measurements. You can page through this "**one channel measurement view**", by clicking the **right/left arrows**.

Navigating

While in run mode, you can view your measurement results in a "one view" measurement screen. The figure below displays an RMS value of 158_{mg} on Channel 1 and profile 1 with HP1 weighed filter. This is displayed as C1P1 on the instrument and represents the x-axis. (See Table 2-1, "Startup screen defined" on page 16 for more details.)



a. Icon indicators – computer power & run mode

b. Measurement settings- RMS value with 1-second logging and HP1 filter

c. Run Time of study

d. Channel 1/Profile 1 (X-axis results)

Figure 5-11: Example of taking measurements in one measurement view

➢ **Navigating one measurement view**

1. Press the **left/righ**t arrow to view the current channels measurement.
2. To view another channel measurements (i.e., channel 2's RMS value) simultaneously press **Alt*f*** and **down arrow** or Press **Alt*f*** and **up arrow**. Continue to press **right or left arrow** to view all measurement results for the selected channel. (Repeat this step in order to view all the channels.)

4-channels measurement view

On the VI-410, you can view up to four channels simultaneously while in run mode, pause mode, or stop mode. This view is selectable via the Display setup menu and can be turned on or off. (See, "Customizing measurement results on the display" on page 51.)

➢ **How to view four channel measurements on one display**

1. To change the measurement view while in run mode (or when viewing past studies) press the down arrow until the 4-channel measurement screen appears.
2. To view all measurement results on a specific channel, first select a channel by pressing and holding ***Altf*** while pressing either the **up** or **down arrow**.

3. Then press **right** or **left arrow** to move (or toggle) through the results. (Repeat step 2 and 3 to view alternative channels.) (See Table 5-1 for details).

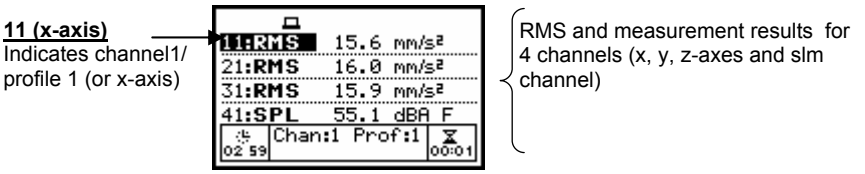


Figure 5-12: Four-channels measurement results screen

Four channel screen view	Explanation
A. Channel indicator	"11" - channel indicator references the first position "1" as channel 1(or x-axis). The second position "1" is referenced as profile 1. (Note: if you created more than one profile per channel, it would also display all the profiles for each channel.
B. Measurement type	RMS is the calculation based on the root mean square (computes the average). The measurement type will cycle through: RMS, VDV (vibration dose value), VEC (vector) , CRF (crest factor), Peak, P-P (peak-to-peak), MTVV (maximum transient vibration value) (See glossary of terms for definitions.)
C. Measurement Calculation	Indicates the amount of vibration based on the measurement type.

Table 5-1: Four-channels measurement results screen explained

Spectrum view

This will appear if 1/1 or 1/3 octave measurement was activated during setup. (Please see "Selecting 1/1 or 1/3 octave band analysis" on page 35 for more information.) *NOTE: When viewing graphical data, simultaneously press **Altf** and **down** arrow and the bars will increase on the display.*

➢ To view, press the up or down arrow continuously until the spectrum view appears (see example below).

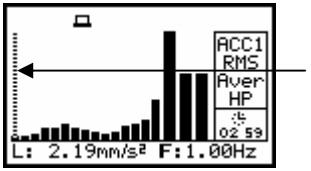
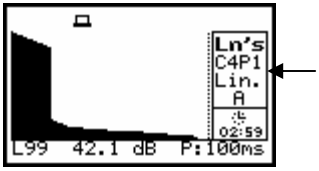


Figure 5-13: Spectrum view

Statistics view

The statistics view will only appear with sound measurement testing.

➢ To view, press the **up or down arrow** continuously until the statistics view appears (see example below).



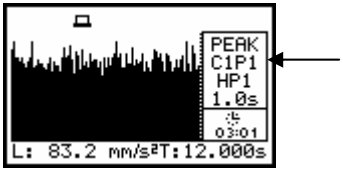
Sound channel measurement results

Figure 5-14: Statistics view

Logger View

Logged data will appear if selected during your setup. There are up to 4 measurement results which could appear in this view which are: Lpk, P-P, Lmax, RMS. (For more information, please see "Saving logged items, on page 33.")

➢ To view, press the **up or down arrow** continuously until the logger view appears (see example below).



Channel 1 (x-axis) Peak measurement results: 83.2 mm/s^2

Figure 5-15: Logger view

Viewing filter analysis data during your study

If you enabled 1/1 or 1/3 octave filter (see "Measurement Parameters" above in this chapter to enable/disable.), you can view these parameters in two different bar graphs depending on how you setup the display mode on the instrument. The following is a walk through on customizing the display mode while running sessions.

✍ ***NOTE:*** *if you plan to view the results after the study with QSP-II software, please see the next chapter "Taking Measurements".*

Screen icons

The VI-410 is equipped with several display or screen icons, which will appear under specific operating conditions. The following is a summary of all indicators/icons that appear on the top of the display. These include “Battery”, “Computer”, “Antenna” (“Tree”), “Loudspeaker”, “Envelope”, “Bell”, “Timer” and “Arrows”).

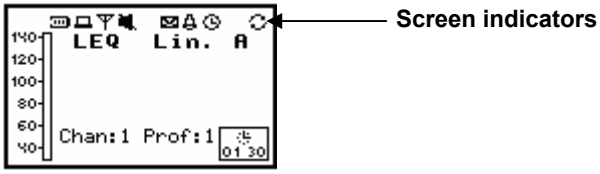


Figure 5-16 Display with all screen indicators

Battery indicator

The battery indicator/icon is displayed when the instrument is powered from internal batteries. (If externally powered, no battery indicator will appear.) The icon indicates the battery power (If three bars appear, this represents a fully-powered instrument, two bars indicates half the battery life, and one bar indicates a quarter of the battery life.)

✍ ***NOTE:*** *When voltage of batteries is too low, the icon will flash. It is highly recommended to plug in an external power cord (USB cable) or insert new batteries. If the instrument is powered off, the last setup is stored and it will appear when the instrument is powered back on.*

Figure 5-17: Battery indicator

Computer indicator

The computer indicator is displayed when there is a USB connection with the PC. The computer indicator/icon will flash during RT (Real-Time) transmission.

Figure 5-18: Battery indicator

Antenna indicator

The antenna (or Tree) indicator is displayed in a flashing mode together with the loudspeaker when the measurement is started, the trigger is switched on and the level of the signal is too low to start the registration.

Figure 5-19: "Antenna" ("Tree") indicator

Loudspeaker indicator

The loudspeaker indicator is displayed when the measurement is started (or in "run mode") and executed. If a line appears through the loudspeaker, this means the measurement is paused (Pause).

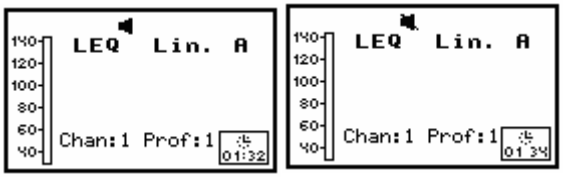


Figure 5-20: Run mode icon (or loudspeaker icon)

Envelope indicator

The envelope indicator is presented together with the loudspeaker when the current measurement results are logged in the instrument's logger file (or data logged files).

✍ ***NOTE:*** *If the envelope starts flashing, this indicates that the memory is full. In order to save the current data, you will have to free up space. (Please access the following menu path and delete some of the "logger files": Menu Path: Menu>File>Defragmentation>Logger defragmentation)*

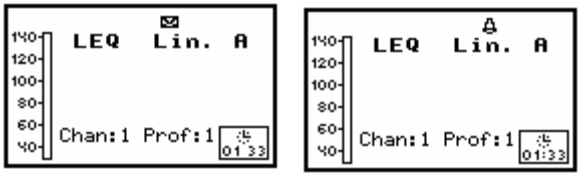


Figure 5-21: Display with "Envelope" (a) and "Bell" (b) icons

Bell (overload) Indicator

A Bell indicator is displayed when an overload has taken place during the last measurement cycle (the icon is displayed also after the measurement and after loading the file with the overloaded results).

Timer indicator

If the Timer mode was used to start a measurement, it will appear on the top of the display. If the Timer indicator appears flashing, this represents that the instrument's timer is switched on and the instrument is waiting for the set time of measurement criteria.

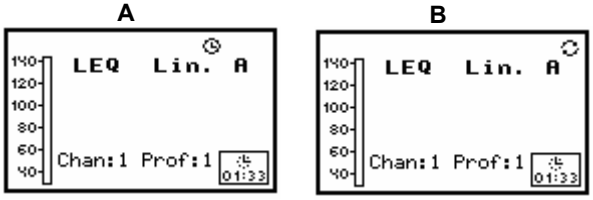


Figure 5-22: Display with Timer (A) and Arrow (B) icons

Arrow Indicator

Arrows will flash after pressing the ***Altf*** key when the 2nd Function is selected in the Altf mode (Menu Path: Menu>Setup>Altf mode>Altf>2nd FUN). This indicates that other push-keys have second or third meaning (For example, you may have changed the keypad settings for the Altf key. If this is the case, the arrows will flash when the new keys are pressed.)

Underrange

In the case of a sound test when the level of the measured signal is too low in relation to the measuring range (when the level of the input signal is under the linearity of the range declared in App. C, called “Underrange”) a vertical arrow will appear in the 4-channel screen. If you are viewing the one-channel screen, the verbiage “Underrange” will appear on the bottom of the display.

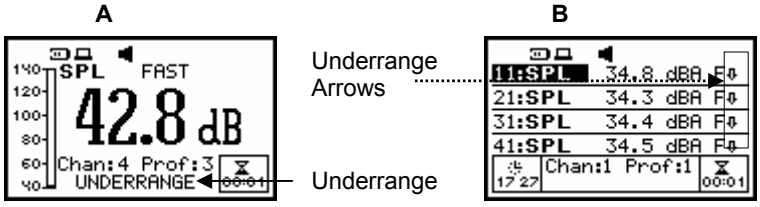


Figure 5-23: 1-channel screen (A) and 4-channel screen (B)

Figure 5-23 explained: *Underrange displays when the level of the signal is too low during the measurements of the sound. “UnderRange” text will appear on the bottom of the display (a) and the arrows directed down in 4 CHANNELS mode (b) will also appear to indicate underrange condition.*

CHAPTER

6

Loading and viewing saved measurements

After taking measurements and storing your data (See “Save Options”, on page 37), you can view time history data, summary data, and frequency analysis results either on the display of the VI-410 or in QuestSuite Professional II software (if purchased). This chapter will address how to view measurements from the VI-410. It will also explain saving, loading, and clearing the stored files (referred as the “buffer” in the Appendix B).

Loading or retrieving your measurement results

Once you have loaded and viewed your results, you can save the data in QSP-II for future analysis and reporting purposes (explained towards the end of this chapter). Additionally, it is recommended to clear the files in order to free up memory space in the VI-410 (see “deleting files” in this chapter).

View saved studies

- ***Menu Path***: ***File>Load File***

1. In the on position, select the menu path indicated above by selecting the following:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼ arrows to highlight **File** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Load File.** Press **Menu/Enter** key.
   - The Load file screen appears (see Figure below)

2. Understanding the Load file screen:
   a. **Line 1 and Line 2** indicate file storage with an assigned file number. The files will save chronologically until cleared. (i.e., file "1" out of "12" files).
   b. **Line 3** indicates the type of measurement mode (level meter for vibration or sound, 1/1 octave, 1/3 octave or FFT) and then displays the setup for channels 1-4. For example, "VVVS" represents vibration data on channels 1-3 and sound data on channel 4.
   c. **Line 4** indicates if you logged data and provides you with the file name.

   ✍ ***NOTE:*** *if you did not turn on data logging and select measurement values, such as RMS and Peak, a file name will not appear after the Logger Name.*
   d. **Line 5 and Line 6** display the date and time of the measurements (or session/study) and the file size.

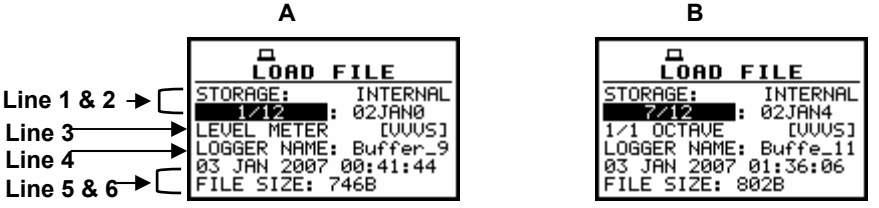


Figure 6-1: Loading files

3. To select and load a file, press right or left arrow to page through the saved files (if more than "1/1"). To load the file, press Menu/Enter key. The VI-410 will state the name of the file and if it loaded ok.
4. Press **Esc** repeatedly until you are viewing the loaded (or retrieved) file (session/study).

Navigating through stored data screens

As discussed in Chapter 5, you can navigate through channels' time history measurements by pressing the **right/left** arrows. To view data on a different channel, press the up or down arrows and the channel (or axis) will change. *For more information on viewing your measurements, please see "Viewing measurement results", on page 83.*

HAV/WBV dose exposure and standards

If you wish to view HAV/WBV dose calculations (i.e., daily exposure results), ensure that your VI-410 has the appropriate settings.

➢ ***Menu Path*: *Input>Auxiliary setup>HAV/WBV Dose setup***

1. In the on position, select the menu path indicated above by selecting the following:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼ arrows to highlight **Input** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Auxiliary setup .** Press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **HAV/WBV Dose setup.** Press **Menu/Enter** key.
   - The HAV/WBV Dose screen appears.
2. If this feature is not already "enabled", press **right arrow** until it is checked. (The checkmark in the "enable" field indicates the dose setup is activated.)
3. Optional: to change the **exposure time** press ▲▼ arrows to highlight this field. Press right arrow repeatedly to increase the time value, or press left arrow repeatedly to decrease the time value.

✍ ***NOTE:*** *To increase/decrease by 30-minute increments, press and hold Altf with either right or left arrow keys.*

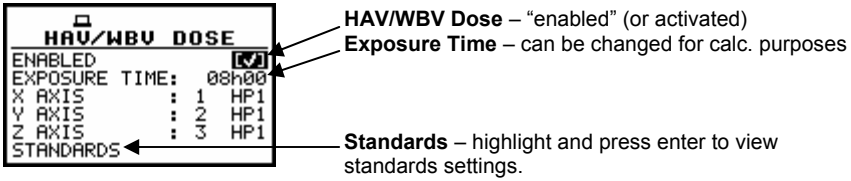


Figure 6-2: HAV/WBV dose screen

4. Optional: to change the **Standards** for **HAV/WBV dose exposure** calculation, highlight standards field and press **Menu/Enter** key.

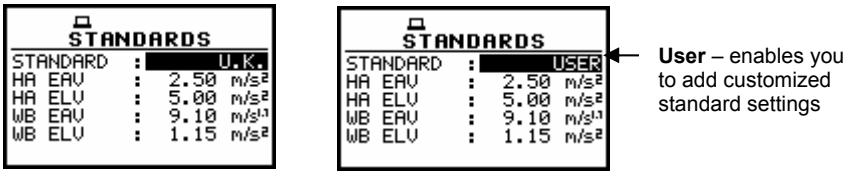


Figure 6-3: Selecting EAV/ELV Dose standards

- The default standards setting is “U.K.”. You have four optional standards including: Italy, Poland, France, and a customizable “User setting”.

- To select a new standard, press **right/left** arrow to page through the settings. (If you select “**User**” as the standard setting, press down arrow to highlight the field you wish to change. Then press **left/right arrow repeatedly** to set a new value.)

- To apply the new standard, press **menu/enter** key. (Or to return to the previous screen, press **Esc** key).

5. Press **Esc** repeatedly to return to the main screen.

Exposure values

With the VI-410, you can select saved studies, load them into either a hand-arm calculator or a whole-body calculator and then view the exposure action values and exposure limit values. (*Note: ensure you have “enabled” HAV/WBV Dose calculation. See “HAV/WBV dose exposure and standards”, on page 93).*

Loading/Selecting exposure dose values

You can load up to six studies in the exposure calculator and then view the results with the following options:

- Partial EAV/ELV
- Partial Results
- Daily Results

The steps below explain how to select the study(ies) and then explain how to view the exposure results.

➢ ***Menu Path***: ***Auxiliary functions>HAV Calculator or /WBV >select results***

1. In the on position, select the menu path indicated above by selecting the following:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼ arrows & highlight **Auxiliary functions** . Press **Menu/Enter.**
   - Press ▲▼ arrows & highlight **either HAV or WBV.** Press **Menu/Enter**.
   - Press ▲▼ arrows and highlight **Select Results.** Press **Menu/Enter**.

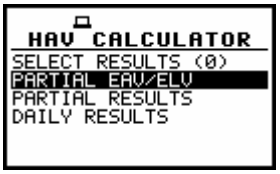


Figure 6-4: HAV calculator screen

   - The Select results screen appears. *(NOTE: The intent of this screen is to load your saved studies.)*

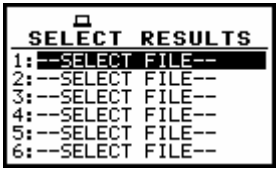


Figure 6-5: Select File screen for dose exposure calculation

2. To select a file, press **Menu/Enter** key and a Select File screen appears.

Figure 6-6: "Empty" select file screen

3. Press **Right arrow** repeatedly until you have selected the appropriate file.

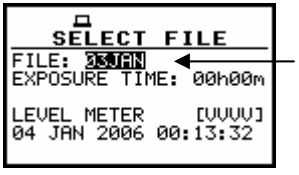


Figure 6-7: Loading or selecting a file for dose exposure

4. Once loaded, press **Esc** key until you return to the HAV Calculator screen or WBV Calculator.

✍ ***NOTE:*** *if you want to load up to 6 studies, repeat steps 1-3. Please see next section "Viewing exposure studies".*

Viewing your exposure studies

As mentioned above in loading exposure dose values, you have three optional exposure result views for HAV or WBV studies. Once the files are selected and loaded, the partial EAV/ELV, Partial results, and Daily Exposure measurements are available. Please follow the preliminary steps in the previous section before proceeding below. (The examples below are for HAV but will be very similar for WBV. To access WBV exposure results, the steps will be the same.)

1. To view **Partial EAV/ELV** screen, from the HAV or WBV calculator screen (see Figure 6-4 for example and instructions), select "Partial EAV/ELV" and press Menu/Enter key. Screen contents explained: The results are displayed in two columns – the first column for EAV results and the second for ELV results.

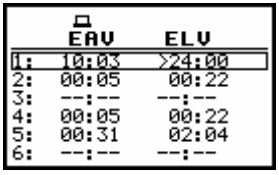


Figure 6-8: Viewing EAV/ ELV exposure with HAV calc.

2. To view dose exposure with **Partial Results** (or A(8)), select Partial Results from the HAV/WBV Calculator menu (see Figure 6-4).
   - Each loaded study will display partial dose exposure results.

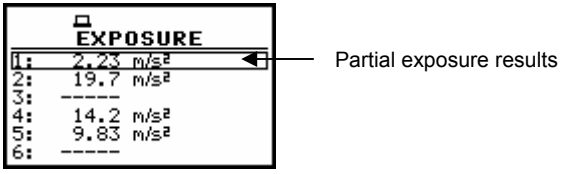


Figure 6-9: Partial results with HAV calc. (or A(8) calculation)

✍ *NOTE: The partial 8-hour time-weighted average exposure, called "Partial results" on the VI-410, is calculated with the following formula:*

- Aeq x $\sqrt{(T/T_0)}$

3. To view Daily dose exposure results, select **Daily results** from the HAV/WBV Calculator menu (see Figure 6-4).

A – HAV results

B – WBV results

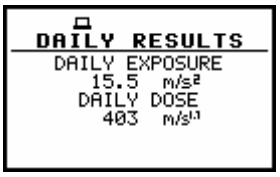


Figure 6-10: Daily Dose Exposure Results for HAV (A) and WBV (B)

Deleting individual studies

You can page through all of your saved studies and delete study by study as needed. When you are viewing a study from the "Delete" menu, it displays the name of the study (i.e., @VIB21), the measurement function (i.e., 1/1 octave band or level meter), identifies if you setting of each channel (sound or vibration level readings), and states the date and time of study. Please follow the steps below to delete your studies.

➢ ***Menu path:*** **File>Delete> Delete**

1. In the on position, select the following menu path:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼arrows to highlight **File** and press **Menu/Enter** key.
   - Press ▲▼arrows and highlight **Delete.** Press **Menu/Enter** key.
   - Press ▲▼arrows and highlight **Result files**. Press **Menu/Enter** key.

2. To delete a study, press right arrow repeatedly until you select a specific file. Press **Menu/Enter** key to delete a study. (Repeat this step to select and delete more than one study.)

Figure 6-11: Selecting and deleting file(s)

3. To return to the main screen or measurement screen, press **Esc** key repeatedly.

✍ ***NOTE:*** *If you want to delete all studies, see "Deleting all studies" for more details.*

Deleting Setups

The VI-410 gives you the option to delete setup parameters one-by-one or you can delete all setups at once. The steps below discuss how to select a setup and delete the parameters individually.

➢ ***Menu path:*** **File>Delete> Setup Files**

1. In the on position, select the following menu path:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼ arrows to highlight **File** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Delete.** Press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Setup files**. Press **Menu/Enter** key.
2. To delete a setup, press **right arrow** repeatedly until you select a specific file. Press **Menu/Enter** key to delete a study. (Repeat this step to select and delete more than one study.)
3. To return to the main screen or measurement screen, press **Esc** key repeatedly.

✍ ***NOTE:*** *If you want to delete all studies, see "Deleting all studies" for more details.*

Deleting all studies, setups, or logged data

With the delete all menu, you can delete all of your studies, setups and/or logged data. Please follow the steps below for details on deleting.

➢ ***Menu path: File>Delete All***

1. In the on position, select the following menu path:
   - Press **Alt*f*** key and the **Menu/Enter** key, to access main menu.
   - Press ▲▼ arrows to highlight **File** and press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Delete All.** Press **Menu/Enter** key.
   - Press ▲▼ arrows and highlight **Setup files**. Press **Menu/Enter** key.
2. To delete all files from the VI-410**,** press ▲▼ **arrows** to highlight **Result files**. Press **right arrow** to add a checkmark . (A checkmark indicates you will delete all files.)
3. To delete all setup files, press ▲▼ **arrows** to highlight **Setup files**. Press **right arrow** to add a checkmark . (A checkmark indicates you will delete all files.)

4. To delete all time history data files, press ▲▼ arrows to highlight **Logger files**. Press **right arrow** to add a checkmark . (A checkmark indicates you will delete all files.)
5. Once you have selected the appropriate files to delete, press Menu/Enter key.
6. To return to the main menu or the measurement screen, press Esc key repeatedly.

File Storage

Checking file storage space

The file storage menu (called "Free Space" on the instrument) indicates the total bytes of memory remaining on the instrument and the total amount of memory on the instrument. This is useful if you are concerned with the amount of data that can be stored on the instrument.

➢ ***Menu path: File>Free Space> Free Space screen***

1. Select the main menu by simultaneously pressing **Alt*f*** key and the **Menu/Enter** key. Arrow ▼ to highlight **File** and press **Menu/Enter** key.
2. Press ▲▼ arrow and select **Free Space**. Then press **Menu/Enter** key. (This will open the Free Space screen.).

Figure 6-12: Example of checking your available storage space

Cleaning up memory (Defragmentation)

Defragmenting the instrument is a good practice if you often delete individual files. This creates blocks of memory instead of one large pool of memory.

➢ ***Menu path: File>Defragmentation***

1. Select the main menu by simultaneously pressing ***Altf*** key and the **Menu/Enter** key. Press ▲▼ to highlight **File** and press **Menu/Enter** key.

2. Press ▲▼ to highlight **Defragmentation** and press **Menu/Enter** key.

Figure 6-13: Defragment screen

3. Press **right or left** arrow to select **Yes** to defragment.
4. Press **Menu/Enter** key to confirm defragmentation.
5. When complete, it will state "defragment complete press any key to continue".
   - Press **Esc** key repeatedly to return to the main menu.

Reviewing your saved studies & settings

You may want to view a listing of all of your saved studies. You can either view the "Catalogue" submenu the "Load" submenu or the "Delete" submenu. These three menus contain the same screen information while you are viewing the contents. The main difference between the three submenus is with the Delete submenu, you can also delete your files. The load files enables you to also view exposure dose results.

Catalog

With the catalog menu, you can review the settings of your saved studies and also view the file size.

➢ ***Menu path: File>Catalog***

1. Select the main menu by simultaneously pressing **Alt*f*** key and the **Menu/Enter** key. Press ▲▼ arrow to highlight **File** and press **Menu/Enter** key.
2. Press **Up or Down arrow** to highlight **Catalog** and press **Menu/Enter** key.

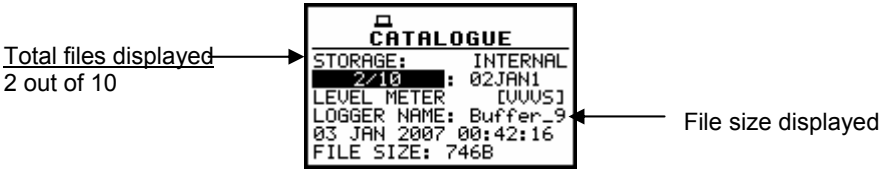


Figure 6-14: Catalog screen lists saved files and file size

3. If you have more than one study saved, press the **right arrow** to page through the catalog. Once completed, press the **Esc** key repeatedly to return to the main screen or the measurement screen.

CHAPTER

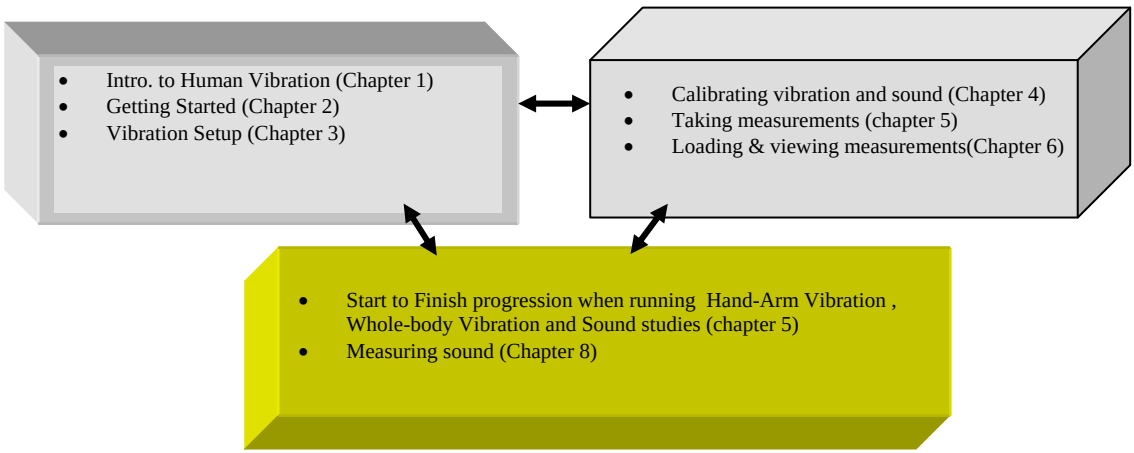
7

At a glance:

HAV, WBV & Sound Studies

In the beginning chapters, the manual discussed basic vibration concepts, and then progressed to vibration setup, running a study, and viewing your study/session results. This chapter is a high-level look at running a hand-arm, vibration study, a whole-body vibration study, or sound study. Please refer to the subsequent chapters for specific steps.

Process Flow: Human Vibration and Sound instructional guide



HAV overview

The checkpoints listed below are typical study procedures for a Hand-Arm Vibration Assessment.

1. **Check Battery:** Check the battery power before and after your study.
2. **Clear memory**: It is recommended to clear the memory of the instrument before starting. (This will give you full memory capacity on the instrument.)
3. **Customize Setup for HAV study**: Using QSP-II, apply Hand-Arm or Hand-Arm Advanced (filters are enabled) setup. If applicable, modify the saved settings for channels 1-3.
4. **Send Setup to VI-410:** Using QSP-II, click Send Setup to Instrument. (Ensure VI-410 is connected to your pc via USB cable before sending setup.)
5. **Inform the Worker:** It is important to notify the worker of the purpose of your study. This will prevent misunderstanding of monitoring his/her job performance.
6. **Place Transducer and VI-410:** Connect the transducer and mounting device to the hand tool and the VI-410.

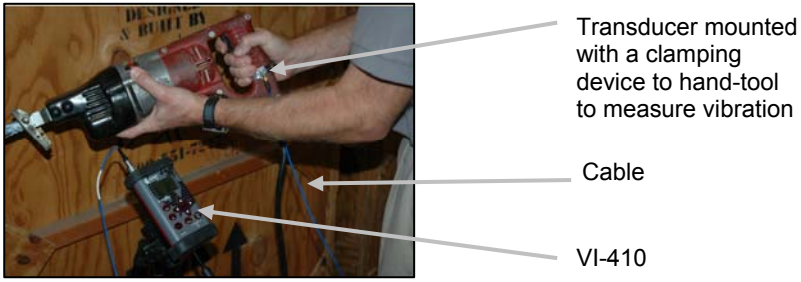


Figure 7-1: Hand-arm vibration example

7. **"Start" mode:** Turn VI-410 to "Start" or run mode.
8. **Work:** Ensure the person who is being surveyed is doing the kind of work that is normally done.
9. **Observe:** Throughout the study you may want to periodically observe the person and measurements on the meter to avoid tampering with the study.
10. **Remove Unit:** After the HAV study, press Stop on the meter. Then remove the transducer and meter from the test site.
11. **Analyze data:** Using QSP-II, retrieve the files from the meter. View the data by accessing the vibration studies from the downloaded tree node. Panels of charts and graphs can be added and customized for reporting and analysis purposes.

WBV overview

The checkpoints listed below are typical study techniques for a Whole-Body Vibration Assessment.

1. **Check Battery:** Check the battery power before and after your study.
2. **Clear memory**: It is recommended to clear the memory of the instrument before starting. (This will give you full memory capacity on the instrument.)
3. **Customize Setup for WBV study**: Using QSP-II, apply Whole-Body or Whole-Body Advanced (filters are enabled) setup. If applicable, modify the saved settings for channels 1-3.
4. **Send Setup to VI-410:** Using QSP-II, click Send Setup to Instrument. (Ensure VI-410 is connected to your pc via USB cable before sending setup.)
5. **Inform the Worker:** It is important to notify the worker of the purpose of your study. This will prevent misunderstanding of monitoring his/her job performance.
6. **Place Seat pad accelerometer and VI-410:** Mount VI-410 and seat-pad accelerometer in the appropriate work area.

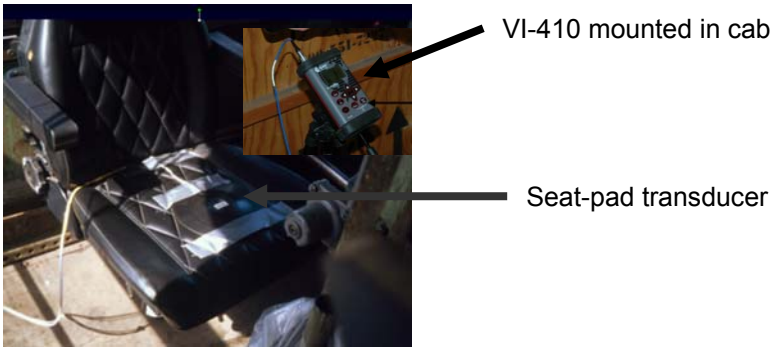


Figure 7-2: Whole-body vibration example

7. **"Start" mode:** Turn VI-410 to "Start" or run mode.
8. **Work:** Ensure the person who is being surveyed is doing the kind of work that is normally done.
9. **Observe:** Throughout the study/workday you may want to stop by and observe the person and measurements on the meter.
10. **Remove Unit:** After the WBV study, press Stop on the meter. Then remove meter and seat-pad from the test site.
11. **Analyze data:** Using QSP-II, retrieve the files from the meter. View the data by accessing the vibration studies from the downloaded tree node. Panels of charts and graphs can be added and customized for reporting and analysis purposes.

Sound overview

The steps outlined below explain the overall process for a sound study.

1. **Check Battery:** Check the battery power before and after your study.
2. **Clear memory**: It is recommended to clear the memory of the instrument before starting. (This will give you full memory capacity on the instrument.)
3. **Customize Setup for sound study**: Using QSP-II, switch to channel 4 setup and select SLM for the mode type. If applicable, modify the settings such as: range (130db), response time (Slow), and filter weighting (A).
4. **Send Setup to VI-410:** Using QSP-II, click Send Setup to Instrument. (Ensure VI-410 is connected to your pc via USB cable before sending setup.)
5. **Calibrate**: Calibrate channel 4 before and check for the calibration for accuracy after the study. The instrument should not change more than 0.5db from the original calibration level.
6. **Inform the Worker:** It is important to notify the worker of the purpose of your study. This will prevent misunderstanding of monitoring his/her job performance.
7. **Place Microphone and VI-410 in the field:** Attach the microphone and pre-amplifier to the meter. Place this in the field.
8. **"Start" mode:** Turn VI-410 to "Start" or run mode.
9. **Work:** Ensure the sound study is setup correctly by observing the measurements on the display during the study.
10. **Remove Unit:** After the HAV study, press Stop on the meter. Then remove the transducer and meter from the test site.
11. **Analyze data:** Using QSP-II, retrieve the files from the meter. View the data using graphs and charts.

CHAPTER

8

Measuring Sound

This chapter will discuss how to run a sound study and include the following areas:

- Customizing your setup options for a sound level study using Quest Suite Professional II software. It will explain how to setup SLM using the VI-410.
- Running a sound study.
- Viewing your sound study results in QSP-II and on the instrument.

Basics of Sound Measurement

A sound level meter (SLM) is a device which measures sound and produces measurement readings from the sound pressure. Figure 8-1 illustrates the basic flow of an electrical signal moving through a sound level meter. It addresses how the range control, frequency filter, and the response choice (Fast, Slow, or Impulse) affect the sound level reading.

Typical Sound Level Meter study

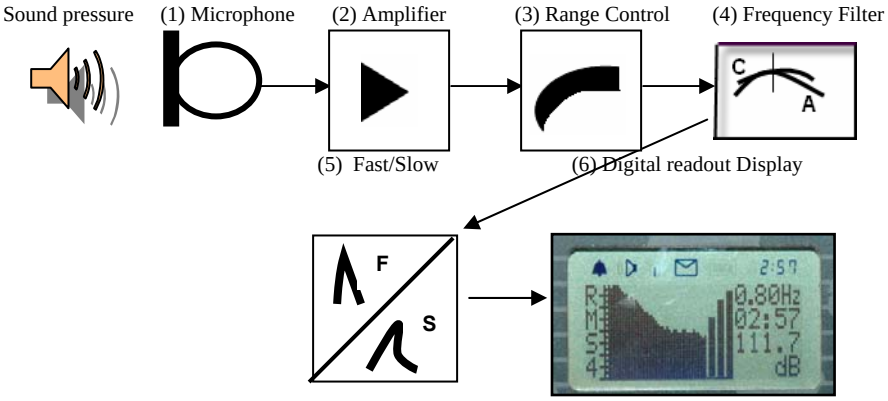


Figure 8-1: Example of basic SLM study

Explanation of SLM study

1. When exposed to sound pressure, the ***microphone*** will generate an electrical signal.
2. This signal will be increased by a ***preamplifier***.
3. The signal is then regulated to an applicable level by the ***range control*** (dB Range).
4. The signal than goes through a ***frequency filter*** or ***weighting system***. In many SLM's, this filter system may consist of an "A", "B", or "C" weighting network, which may or may not be bypassed with a linear (or LIN) function.
5. The subsequent circuit is the ***response circuit***, which controls the dampening of the readout.
   - The responses are ***Slow, Fast, or Impulse***.
6. The last stage is a ***readout display*** by either an analog meter or a ***digital display***. The readout may be monitored by an external device via an AC or DC output, or can be stored in a data logger.

✍ ***NOTE:*** *The VI-410 has a built-in internal data logger.*

Setting up a Sound Study

If this is the first time operating the instrument as a sound level meter, you will need to do a little assembly before logging data. The following procedures will walk you through the physical setup and then explain various sound settings.

Equipment for sound study

You will want to gather the equipment identified below before you begin your sound study.

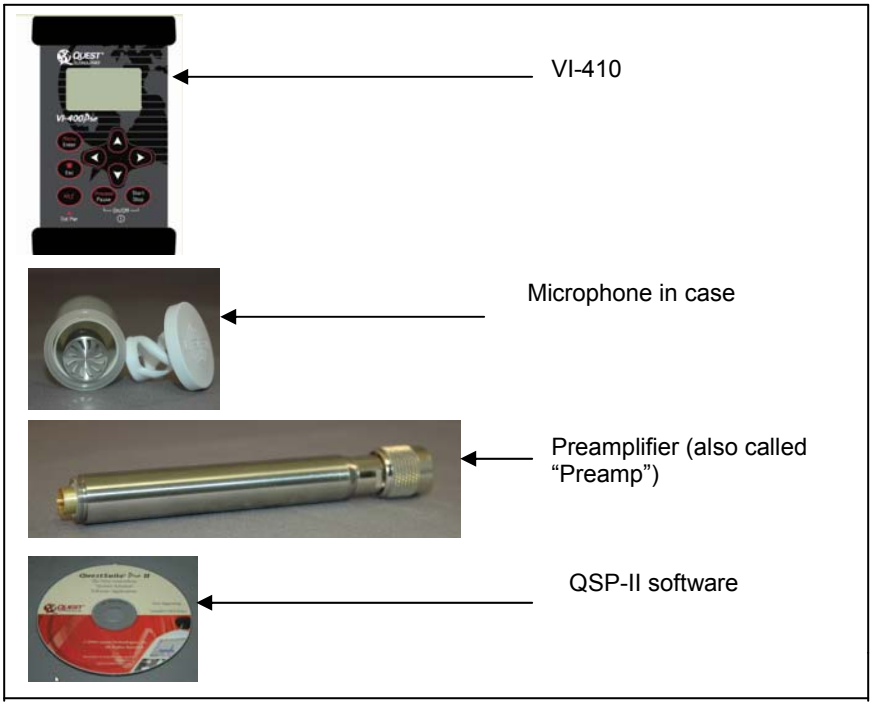


Figure 8-2: Equipment for sound level test

Physical Setup

The microphone and preamplifier are delivered in separate cases. These two devices should be connected to the instrument before beginning your study.

➢ **Attaching the microphone to the preamp**

1. Carefully remove the microphone from the carrying case.
2. Thread the microphone on the preamp by twisting the microphone until it fits tightly.

Figure 8-3: Connect preamp to microphone

3. Taking the opposite end of the preamp, twist this device onto the VI-410.

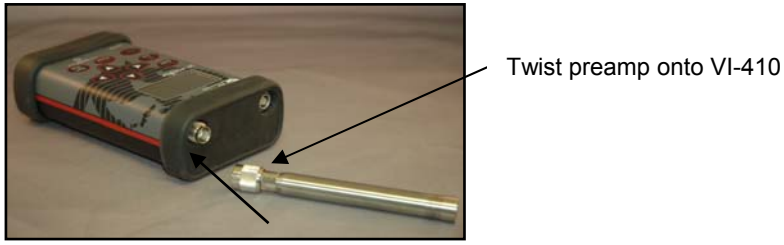


Figure 8-4: Connecting the assembled mic/preamp to VI-410

4. Once it is fully assembled, you are ready to program the settings for your Sound study.

Figure 8-5: Example of instrument fully assembled for sound study

Setting up a sound study with QSP-II

There are two methods to set up a sound study. This manual discuses how to setup a sound study with QSP-II. (Please see chapter 3 to setup your study using the keypad of the instrument.)

Opening Set-up screen

1. From your desktop, click on QSP-II software icon.
   (Or open it from Program Files).

✍ ***NOTE:*** *if you have not installed QSP-II software, please follow steps on QSP-II CD or on the Quest website.*

2. In **My Instruments** panel, select **Vibration** and then select **VI-410** icon.
3. Select the **Setup** 

key.

Figure 8-6: Selecting setup from "My instruments" panel

Customize channel setup for SLM

1. Once the **setup** menu is opened (see steps above, "How to open the setup screen"), click on "**Channel 4**" tab.

✍ ***NOTE:*** *Channel 4 is the default for sound level mode. However, you can quickly change this by setting up channel 1, channel 2, or channel 3 for SLM. To do this, click on the appropriate channel to designate for SLM mode and continue to step 2.*

2. To select the **basic SLM settings**, click on the drop down arrow and click again on the appropriate setting. Table 8-1 explains the settings.

Basic SLM settings	Explanation
Mode	The mode is either for Vibration level meter (VLM) or Sound level meter (SLM).
Range	The range represents the highest level for your sound level test. The selections are 105dB or 130dB.
Mic. Correction	Different types of microphones can be used in your test which are: **Free Microphone**, **Diffuse Microphone** (typically used in room acoustics) or **Outdoor Microphone**

Table 8-1: Basic SLM settings

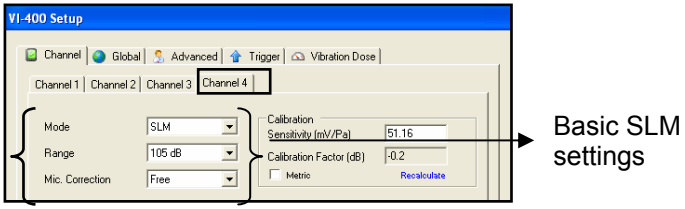


Figure 8-7: setting up mode, range, and mic. for SLM

3. To select **profile settings**, click on the drop down arrow and click again on the appropriate setting.

Table 8-2 explains the settings and Figure 8-8 illustrates profile settings.

Profile settings	Explanation
Profile	Profile is a feature that enables you to define up to three profiles/settings for the sound level meter (or VLM). ● For example, you may want to run a test with different response settings and filter weightings and compare the results.
Response	The response determines how quickly the unit responds to fluctuating sound. Fast has a time constant of 125 milliseconds. Slow has a time constant of 1 second. Impulse is used for measuring loud sounds with short durations.
Filter Weighting	"A", "C", and "Z" are standard frequency filters that cover the frequency range of human hearing (20Hz to 20kHz). ● "***A" weighting*** is the most commonly used filter. It attenuates the frequencies below several hundred hertz as well as the high frequencies above six thousand hertz. (Typically reported as dBA.) ● "***C" weighting*** provides a flat frequency response with only slight attenuation of the very high and low frequencies. (Typically reported as dBC.) ● ***"Z" weighting*** covers a flat range of 20Hz to 20kHz.)

Table 8-2: Profile settings

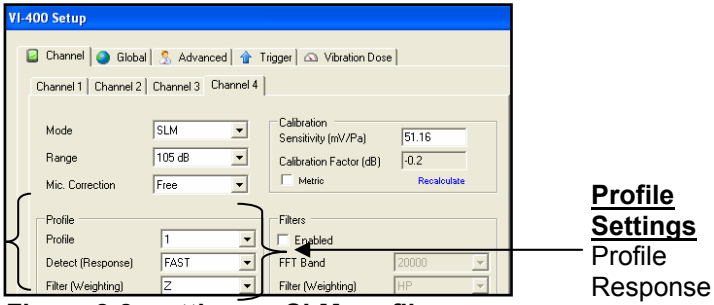


Figure 8-8: setting up SLM profiles

4. To save **logged items** for measurement results, choose one of the following by clicking in the appropriate measurement box (see Figure 8-9):
   - **Lpk** ~ peak sound pressure level with C-weighting
   - **Lmax** ~ maximum sound pressure level with C-weighting at slow response.
   - **Lmin** ~ minimum sound pressure level with C-weighting at slow response.

- **RMS** ~ average sound pressure level with C-weighting at slow response.

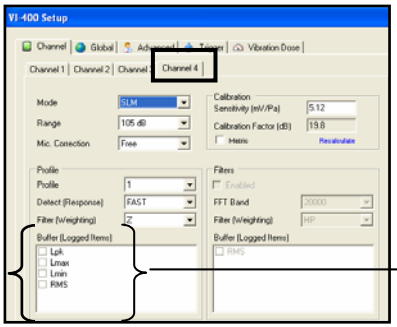


Figure 8-9: Setting up SLM profiles

5. To enter **calibration level,** type in the calibration sensitivity. Click on the **recalculate** key to adjust the calibration factor.
6. To apply **filters**, ensure under "Global" tab that 1/1, 1/3, or fft is enabled. (See "How to customize global and advanced settings" for details).
    - Select the appropriate filter weighting by checking "enabled". Then choose a filter weighting (i.e., HP).

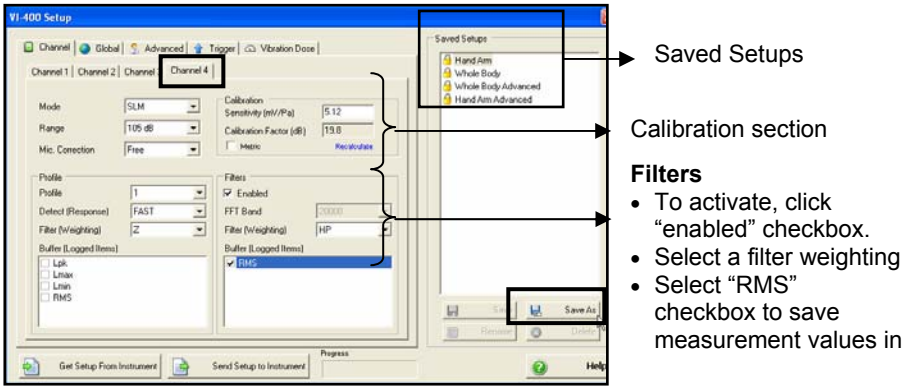


Figure 8-10: Setting up calibration and activating filters

7. To save these settings, click on S**ave As** and name your setup file. It will automatically add to the "Saved Setup" section.

- To continue to modify your sound settings, refer to the next section.

✍ ***NOTE:*** *you can modify your Saved Settings, by clicking on the file name, making changes, and saving the changes.*

- Or to continue modifying setup features, please refer to the next section.

Customizing global settings

In the global tab, you have the option of enabling a filtered frequency such as: 1/1 octave band filter, 1/3 octave band filter, FFT, or leave the default setting as "level meter". You also can modify the following features:

- Changing the beginning delay time of your study (called "start delay")
- Changing the overall length of the studies "run time"
- Modifying the logging rate time of your study (also called buffer time). If set at 1 minute, the study will store measurements at one minute intervals.
- Changing Autosave mode to store or not store measurements.
- Changing the name of your study. The default is set as "VIBX". Each file saves in numeric order and starts in the following sequence unless modified: VIB0, VIB1, VIB2 and continues to increase numerically.
- Enabling or disabling Save Statistics feature.

Enabling frequency analysis

As explained above, you have three options for frequency analysis measurements which are: 1/1, 1/3, and FFT. The steps below outline how to enable this feature.

1. In the **setup** menu, click on the **Global** tab.
   - Follow steps, "How to open setup screen" to access setup in QSP-II.

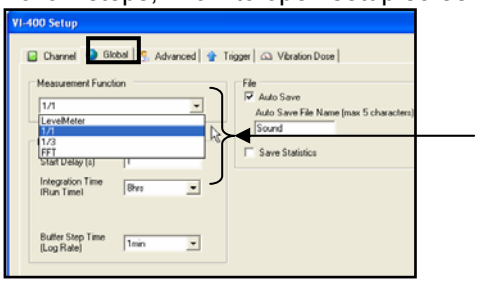


Figure 8-11: Setting up frequency analysis measurement

2. In the Measurement Function section, click on the **drop down arrow** and click again on the appropriate feature.
3. To save the setting, click on **Save As** and name your setup file.
   - Or continue to modify your settings by referring to the next section.
   - Or refer to “send settings for SL study”.

Modifying start delay and log rate time

The default start delay time is set for one second. You may have a situation in which you need additional lag time before starting your study. The steps below detail and illustrate how to change this feature.

You also have the option of changing the “Run Time” of an overall study. The default setting is set at 8 hours.

✍ ***NOTE:*** *if you plan on running the instrument for a full 8 hours ensure you have full battery power (see “checking battery power” in Chapter 2 for details).*

1. In the setup menu, click on the **Global** tab.
   - Follow steps, “How to open setup screen” to access setup in QSP-II.

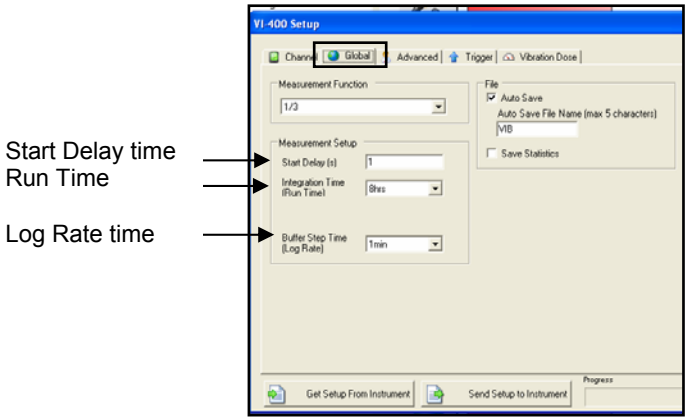


Figure 8-12: setting up time elements in QSP-II

2. To change the **Start delay time**, click in the box and highlight the displayed number. Type over the existing number.
3. To change the **Run time**, click on the drop down box and select a new overall run time for your study.

4. To change the **Log rate time**, click on the drop down box and select an alternative interval.
5. To save the setting, click on **Save As** and name your setup file.
   - Or continue to modify your settings by referring to the next section, "Working with save options and file naming."
   - Or refer to "Send settings for SL study".

Working with Save options & File Naming

The VI-410 is automatically setup to save studies. This can be disabled by a quick click of your mouse. In the file section of QSP-II, you also can enable or disable the "save statistics" feature.

In addition to the save features, you also have the ability to change the file name of each study. The default for all studies is set as "VIB" and it automatically increases by 1. Without changing the default file name, the first file would save as "VIB0", the second study would save as "VIB1" and would repeat this pattern.

It is recommended to change the file name to "Sound" or something that equates to a sound test. Then, the program will automatically save in the following format: Sound0, Sound1, Sound2, Sound3; and so on.

Modifying save options and file name

1. In the setup menu, click on the **Global** tab.
   - Follow steps, “How to open setup screen” to access setup in QSP-II.

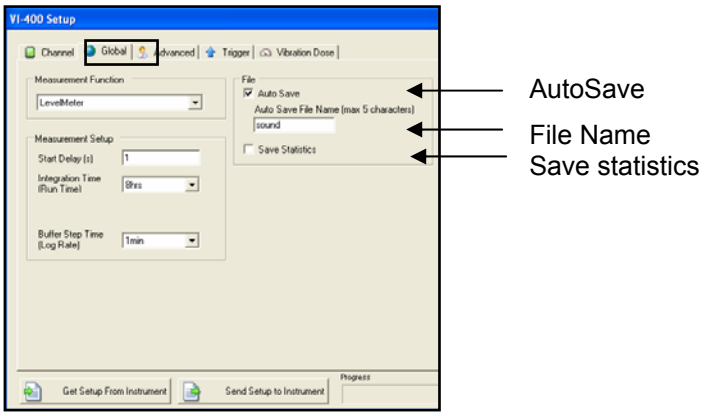


Figure 8-13: Setting up time elements in QSP-II

2. To disable/enable, Autosave do one of the following:
   - To **disable** ~ uncheck **Autosave** box
   - To **enable** ~ check **Autosave** box
3. To change the **file name**, type in a new file name.
   - Such as: “sound”. The first file will save as “Sound0” the second file will save as “Sound1” and continue to save numerically.
4. To **save statistics**, click in the “Save Statistics” box. To disable, uncheck “save statistics”.
5. To save the setting, click on **Save As** and name your setup file.
   - Or continue to modify your settings by referring to the next section, “Customizing advanced settings”.
   - Or refer to “Send settings for SL study”.

Customizing advanced settings

In the advanced settings, you can change the external input/output device type and select appropriate input type. The steps below detail how to change each of these settings.

✍ ***NOTE:*** *Vector Coefficient is displayed in the Advanced tab. This is only applicable for vibration calculations when determining the vector sum. Thus, the advanced tab will not be discussed in this chapter.*

External Input/Output

External I/O refers to external device connections. This feature enables a user to connect the VI-410 to another device such as a recorder.

1. In the setup screen, click on the **Advanced** tab.
2. In the external I/O section, click on the mode **drop down box** and select one of the following:
   - Analog - AC output can be observed on an oscilloscope.
   - Digital In - can be used for an external trigger.
   - Digital Out - can be used as a trigger pulse.
3. In the **channel drop down box**, select the appropriate **channe**l for external device.

✍ ***NOTE:*** *Channel 4 is the default for sound channel. If you changed this in your setup (explained in "Customize channel setup for SLM"), you would select that channel number.*

4. In the **input section**, click on the drop down box and select either linear or exponential.
5. To save the setting, click on **Save As** and name your setup file.

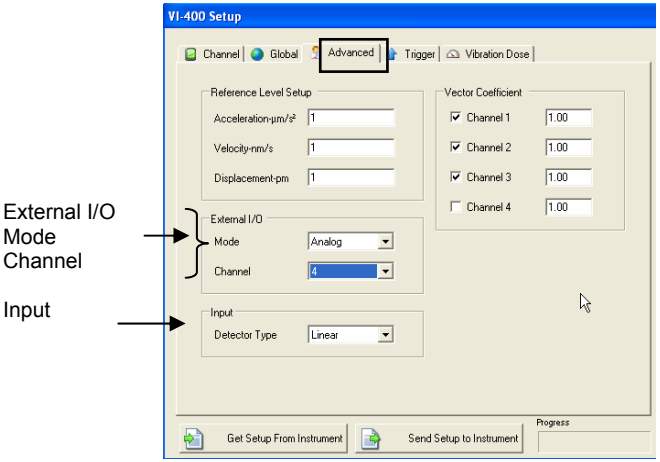


Figure 8-14: Setting up mode & channel for SLM

Disable vibration level mode

You may want to disable vibration level readings on channels 1-3 before you begin your sound study. If you choose to leave the default vibration settings, then during a sound study the meter will display measurement values on channels 1-3 as well as measurement values on channel 4.

1. Open QSP-II and select **VI-410** from My Instruments panel.
2. Click on the appropriate device in the VI-410 listing, and then click **Setup**.
3. In the Setup box, click on Channel 1. Uncheck the measurement values in the Logged Items section.

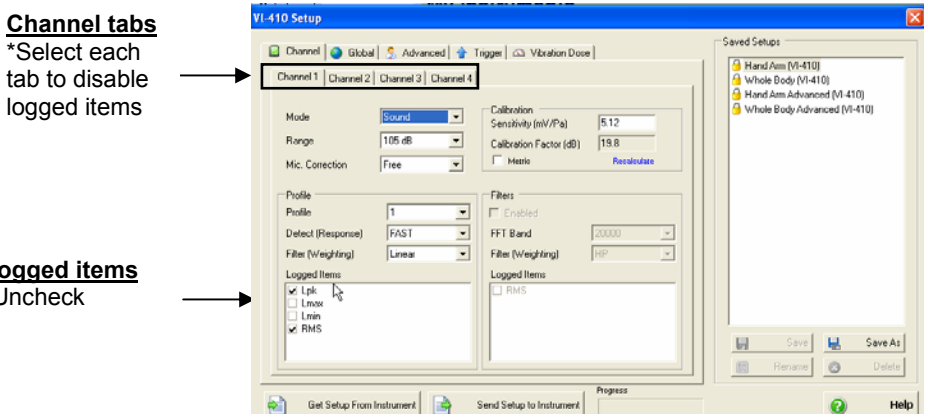


Figure 8-15: Changing settings for channels 1-3

4. Click on **Channel two** and uncheck Logged items.
5. Click on **Channel three** and uncheck Logged items.
6. Click **Save As** to rename your setup or click on the **Save** settings file and then Rename the saved setting.

Working with Trigger mode for SL study

The instrument can be set to operate in a trigger mode. Triggering can take the place of the manual use of Starting a study (Start/Stop key) and Stopping a study (Start/Stop key). It can also be used to monitor runs with specific sound pressure levels in relation to set points.

Slope+ or Slope-

- When the ***Slope+*** mode is selected, the measurement starts when the signal **increases** past a specified **signal source** (i.e., vector/sound value) and a specified sound level (also called **SLM level**). It will continue to store measurement values until the "run time" (also called integration time) is reached or if you manually stop the study. The default for the "run time" value is set at 8 hours

- When the ***Slope-*** mode is selected, the measurement starts when the signal **decreases** past a specified signal source and a specified vibration/sound value and will continue to store measurement values until run time is reached or if you manually stop the study.

Level+ or Level-

- When the **Level +** mode is set, the triggering condition is checked each second; the measurement is saved only when the signal is ***greater than*** the signal source level and in any other cases the measurement result is not stored.
- When the **Level -** mode is set, the triggering condition is checked each second; the measurement is saved only when the signal is ***less than*** the signal source level and in any other cases the measurement result is not stored.

Logger

In the Logger trigger mode, a pre and post logging rate is specified. If the logging rate is set at 15 second intervals for the pre and post intervals, for example, the logger will look at all the measurements and store only the study time 15 seconds before and 15 seconds after the study.

Setting Trigger mode for SL study

1. In the setup screen, verify that channel 4 is setup for your sound study.
   - If you saved a sound setup, click on sound setup then proceed to step 2.
   - If you did not save a sound setup, setup channel 4 with the appropriate settings. Then, Save the setup by selecting Save As key (lower right-hand side of screen). Type in a new setup name and click Ok.

2. Click on the **Trigger** tab. Select a mode, signal source, a channel (channel 4 indicates Sound study), select a value for SLM level. Delete the VLM level. (See Figure 8-16 and Table 8-3 for explanation.)

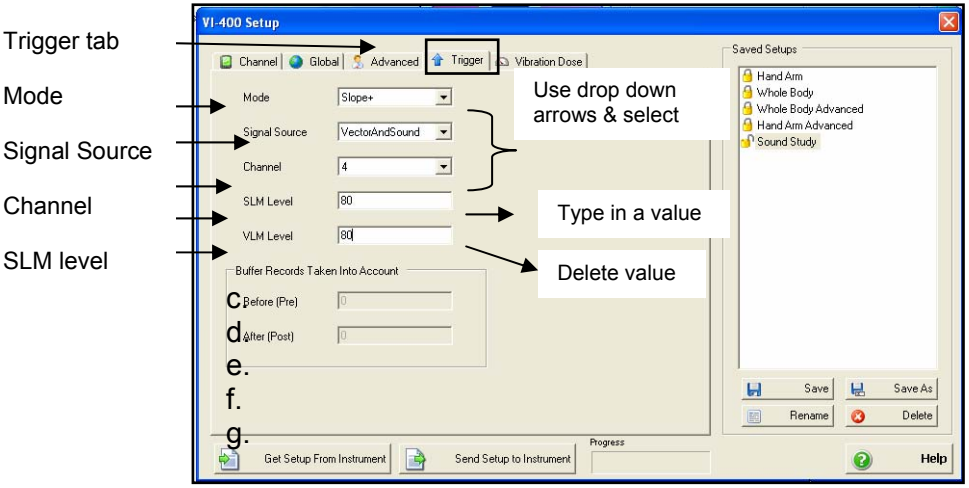


Figure 8-16: Defining trigger settings for SLM in QSP-II

Trigger Modes	Signal Source selectable options
Slope +/-	• Vector and Sound • Maximum
Level +/-	• Vector and Sound • Maximum
Logger	1. Select Signal source option • Vector and Sound • Maximum • Measurement value 2. Type in a Pre or Post value for the buffer test such as, 15 seconds before a study and 15 seconds after a study.

Table 8-3: selecting signal source for trigger setup

3. Save your setup by either updating your current “saved setups” file. (To save current setup, click on the file, in saved settings and select **Save** key.)

- Or click **Save a**s key and assign new name (i.e., sound study with triggers)

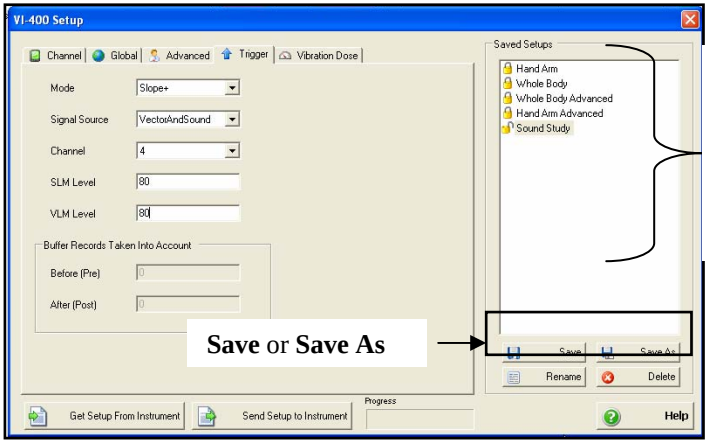


Figure 8-17: illustrates saving your trigger setup

Sending settings for SL study

1. Using the **USB cable**, plug the cable into the instrument (Figure 8-18A) and then connect the instrument to your computer (figure 8-18B). Ensure that the VI-410 is in the "**On**" position.
   - (To turn on VI-410, simultaneously press the **Proceed/Pause** key and **Start/Stop** key.)

A. Connect USB to instrument

B. Connect USB to your pc

Figure 8-18 A and B: Connecting the instruments to the pc

2. In QSP-II, select the **setup** key for the VI-410 instrument.
   - See section above, "How to open setup screen" for more details.

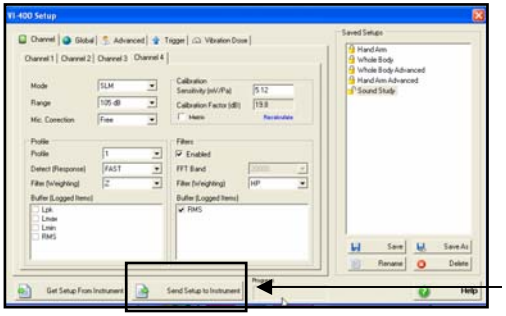


Figure 8-19: Send setup key

3. Select the appropriate Sound setup in the Saved Settings (see Figure 8-17).
4. From the setup screen, click on the **Send Setup to Instrument** key.

✍ ***NOTE:*** *The software screen will show a progress bar*  *and it will state, "data successfully sent to unit" once it is complete.*

Get setup from instrument

Once all of your settings have been selected and saved, you can send the parameters to the instrument.

1. Using the USB cable, connect the instrument to your computer. Ensure that the VI-410 is in the "On" position.
   - To activate, simultaneously press the **Proceed/Pause** key and **Start/Stop** key.
2. In QSP-II for the VI-410 instrument, select the instrument from the menu and click on the Setup key.
   - See section above, "How to open setup screen" for more details.

3. In the setup screen, click on **Get setup from instrument** (see Figure 8-20).

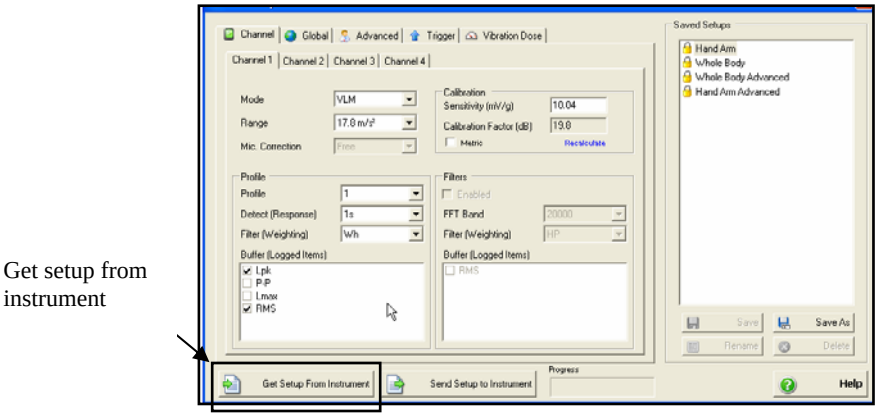


Figure 8-20: Get setup from instrument

Running and viewing a Sound study

By this point, you should have the instrument connected to the microphone (as illustrated above) and customized settings for a Sound level study.
The next step is to position the instrument in the field. When you are ready to begin your study, follow the steps below.

1. To begin the study, press the **Menu/Enter** key.
   - The following **screen indicators** describe type of study and the measurement value is displayed on Channel four with a Peak value of 120.7 dbA.

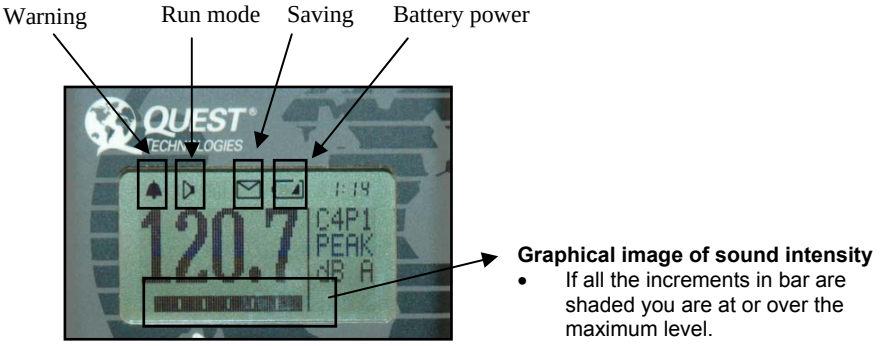


Figure 8-21: Sound level run mode screen

2. To page through different time history values, press the **right/left** arrows.
3. To view 4 measurements on one screen, press the **down arrow** until three measurements are displayed.

42: SPL
- Indicates channel four value in profile 2

43: SPL
- Indicates channel 4 value in profile 3

Figure 8-22: "Four measurement view" during SL study

✍ ***NOTE:*** *If you did not define additional setups for your channel 4 sound study (called profiles), then the measurement values displayed in "channel 42" and "channel 43" will display the same value as "channel 41".*

4. To view frequency analysis filter, press the **down arrow** until you see a graphical view of the spectrum appear. (Note: this has to be applied before you start your study. Please reference, "Enabling frequency analysis" for setup explanation.)

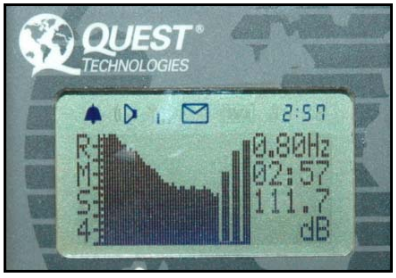


Figure 8-23: Viewing 1/3 octave band during a sound study

Stopping or Pausing a SLM study

While you are running a study, you can either pause a study and then start it again (also called trigger on or trigger off) or stop your study.
After running your sound studies, you are ready to take the stored data from the instrument and send it to QSP-II.

Retrieving Data for SLM

1. While the VI-410 is in the “on” position, plug the USB cable into the VI-410 and then, connect this to your pc.
2. Open up QSP-II software and under **My Instruments** click on **Vibration,** click on **VI-410,** select the proper unit from the Device Name list, then select **Retrieve Data.**

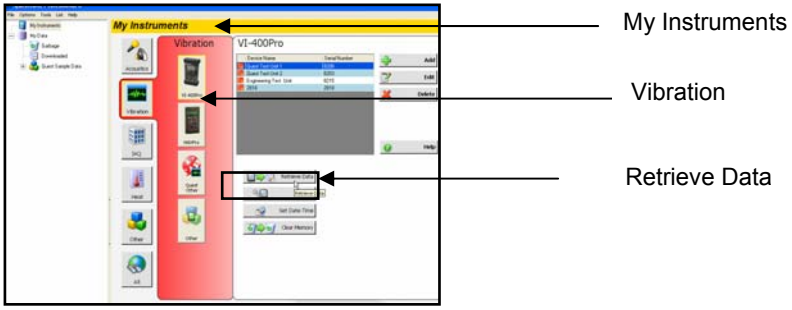


Figure 8-24: Retrieve data key for SLM study

3. In the Retrieve Data dialog box, click on **Select All** and then click on the **Download** key.
   - Or check the appropriate studies and then select Download key.

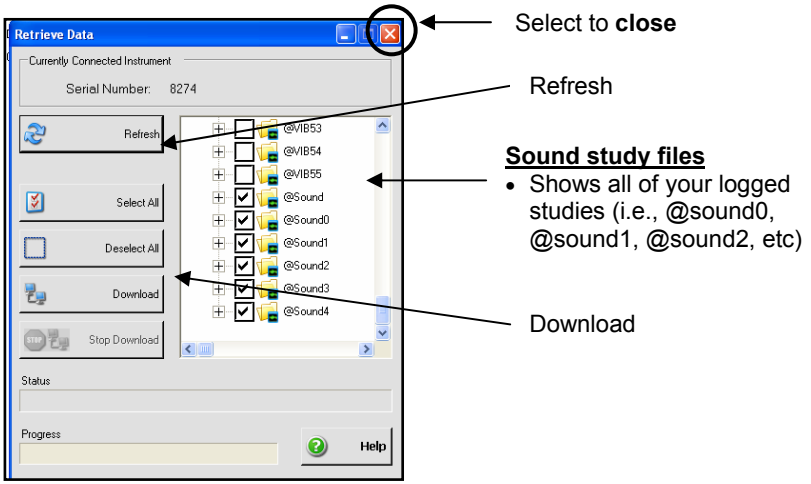


Figure 8-25: Example of retrieving data from QSP-II

4. Once it is downloaded, you will get a message stating “Download Complete”. Click on the “**X**” to **close** the retrieve dialogue box.

Displaying sound studies in QSP-II

Now that your studies have been moved from the instrument to the software, you can view various graphs and charts using Quest Suite Professional II.

1. In the **Tree Nodes**, click on “**Downloaded”** to expand the node.

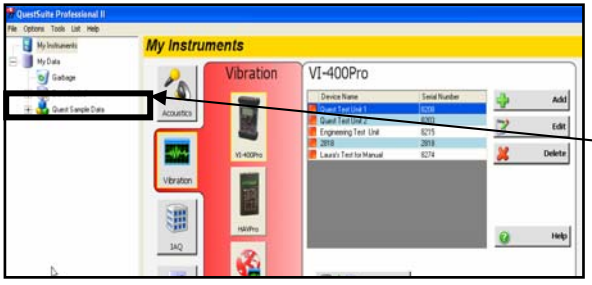


Figure 8-26: Accessing SLM, downloaded files from QSP-II

2. Click on the appropriate **study** you wish to view and the study will expand out to Sound file and “Meter Config” files.

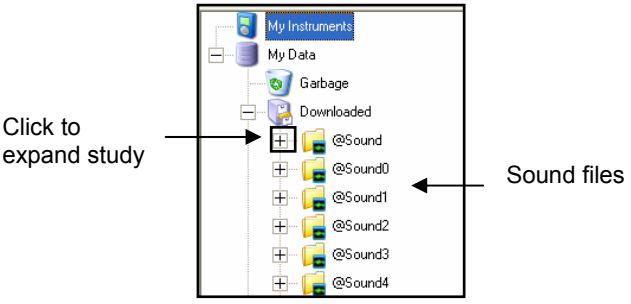


Figure 8-27: Example of Downloaded sound files

3. Click on the **file** which is indicated with a red book icon

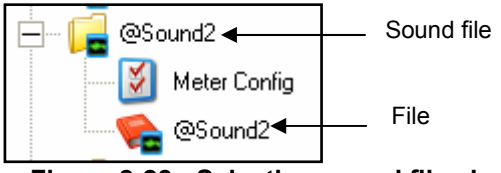


Figure 8-28: Selecting sound files in QSP-II

4. On the right-hand side of QSP-II, your logged study is displayed in graphs and charts (see Figure 11-29). (For more details on Charts and graphs, see next section, “Understanding graphs and charts”).

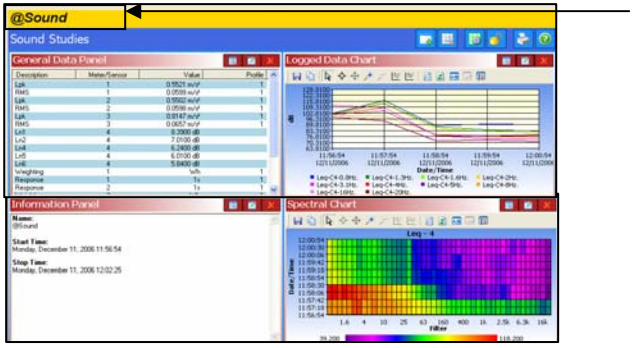


Figure 8-29: Example of viewing charts and graphs in QSP-II

Tables and charts layout view

You can add, edit, print, and export data in QSP-II. The following diagram illustrates the main features and menu bars in QSP-II.

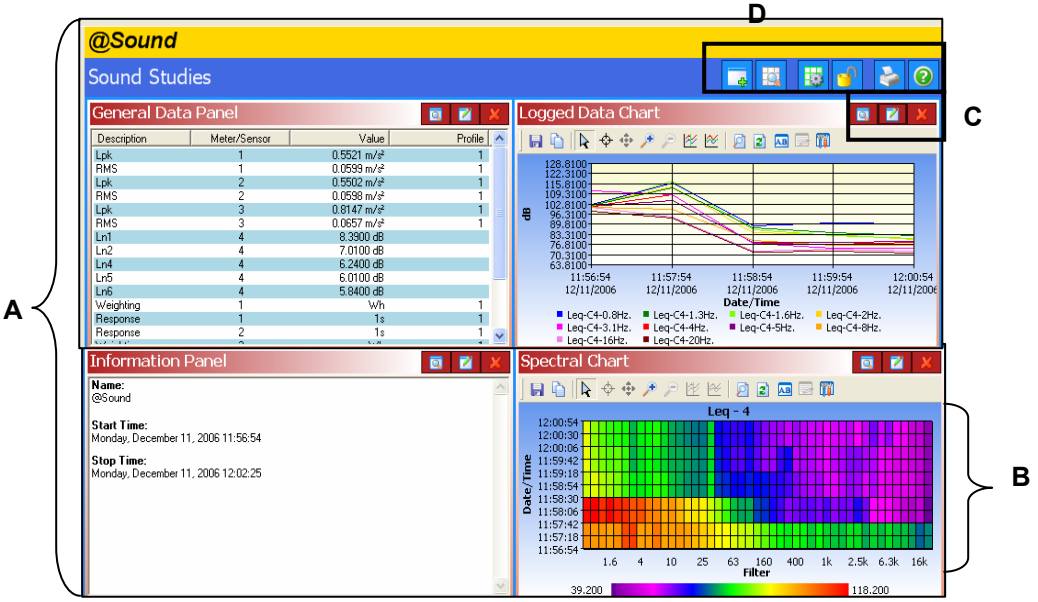


Figure 8-30: Example of Graphs and Charts SLM layout view in QSP-II

Graphs & Charts layout view	Explanation
A. Layout	The layout is divided into panels which can be customized in "manage templates" icon.
B. Panel	The standard layout has four panels on each screen which can be added or deleted by using the Add icon.
C. Chart & Graph icons	Used to enlarge or hide the chart or graph (also called panel), Edit the data, or close the view.
D. Layout icons	Used to add tables or charts, arrange tables or charts, manage the layout view, lock it, print reports and help files.

Table 8-4: Explanation of graphs and charts layout view

Customizing charts and graphs in QSP-II

Once you are in the layout view, you may have to click on each panel and customize the chart or graph to channel 4. This is dependant on if you turned off the buffer measurements on channels 1-3 during the setup phase.

1. In the appropriate panel (example below illustrates "logged data chart"), click on the "**Edit Panel**" icon.

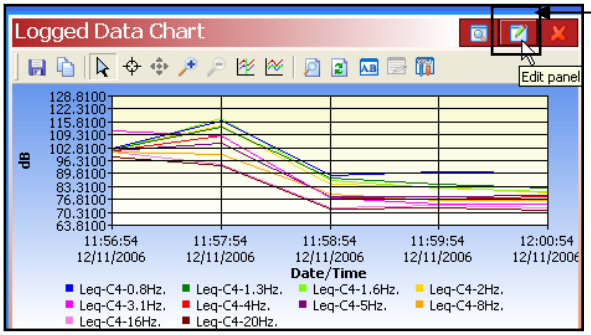


Figure 8-31: Edit panel icon option

2. Click on the “Channel 4” tab and select measurements you wish to view. (Click on “Select All” to view all the values.)

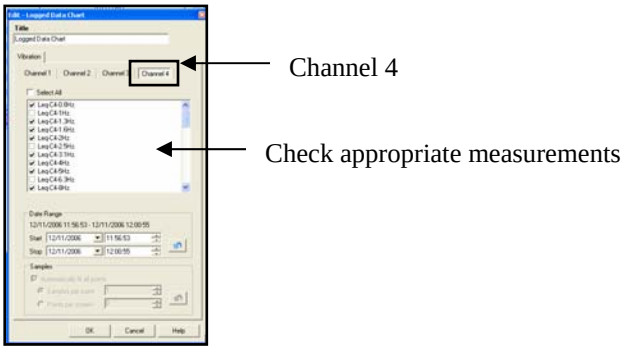


Figure 8- 32: Selecting measurements which will appear on chart/graph

3. To turn off channel’s 1-3 data, click on each channel and uncheck measurement values.

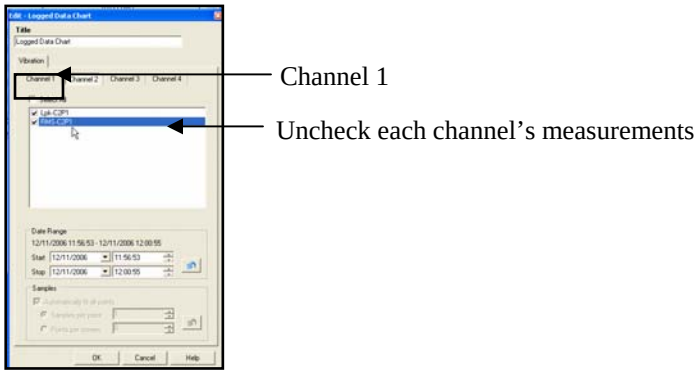


Figure 8-33: Disabling vibration measurements in QSP-II’s charts and tables

4. Click **Ok** when complete.

✍ ***NOTE:*** *If you want to ensure vibration channels 1-3 are disengaged for sound studies, see above, “Disable vibration level mode”.*

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CHAPTER

9

QSP-II

In three easy to follow sections, this chapter will guide you through communicating, setting up options for HAV or WBV study(ies), and explain how to send the setup features to the instrument.

✍ ***NOTE:*** *For information on manually setting up the instrument without help of QSP-II, please follow the procedures in Chapter 3.*

- **Communicating with QSP-II and your pc -** steps and diagrams detailing how to connect and add QSP-II.
- **Working with the set-up features -** an explanation of setting up and saving your settings.
- **Sending settings to instrument -** details how to send your setup features to the instrument.
- **Retrieving and downloading data -** explains how to retrieve data and review the results from the downloaded node in charts and graphs.

Communicating and downloading data

If you haven't downloaded QSP-II software, please follow the instructions on the CD. Once installed, you will want to gather the USB cable and the VI-410.

➢ **Connecting the VI-410 to your pc**

1. Turn on the VI-410.
   - Simultaneously press **Proceed/Pause** key and **Start/Stop** key.
2. Connect USB port to your pc. (See "B" in Figure 9-1)**.**

3. Connect the USB cable to the VI-410 (See “C” in Figure 3-2).

Figure 9-1: Connecting VI410 to PC/Laptop

A. Power on VI400-Pro. **B.** Connect USB to pc
C. Connect USB from pc to VI-410

4. Open **QSP-II** software from your desktop. (Double-click QSP-II icon.)
5. In **My Instruments**, click on **Vibration** key and then click on **VI-410** key. It will automatically load the instrument into the VI-410 section of the screen.

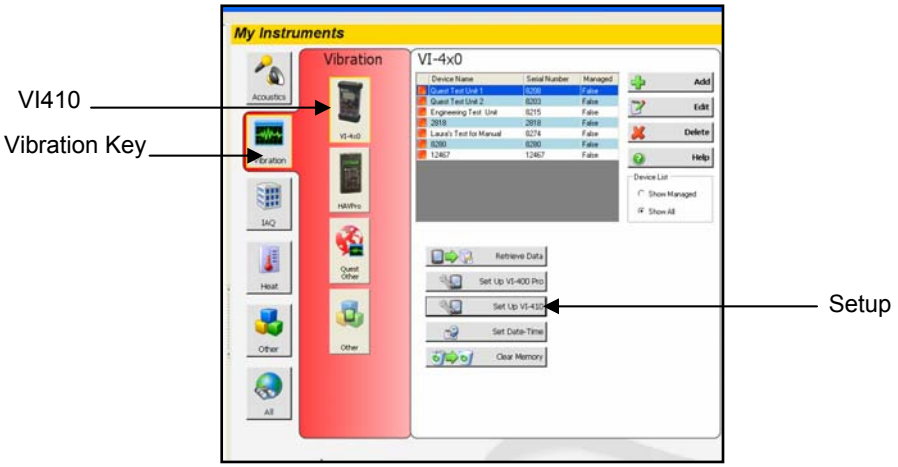


Figure 9-2: Selecting VI-410 in QSP-II

Working with Set-up features

Now that you have installed the QSP-II software and connected the instrument to your pc, you are ready to work with the setup screens in QSP-II. The

advantage to working in QSP-II is that you can quickly save multiple setups, access them in the saved settings screen, and send it to the instrument.

Channel (x, y, z) measurement setup

Open QSP-II and ensure the instrument is attached to the pc.

- For more details, refer to "Connecting the Instrument" above.

From the "My Instruments" view in the VI-410 panel select the **Setup** key. Please refer to Figure 9-3.

In the **Saved Setups** section, click on one of the following:

- ***Hand Arm***
- ***Whole Body***
- ***Whole Body advanced (1/3 octave filters are enabled)***
- ***Hand Arm Advanced (1/3 octave filters are enabled)***

✍ ***NOTE:*** *In this example, there are four **Saved Setups** for hand arm vibration and whole body vibration. With Hand arm advanced setup, filters are enabled for 1/3 octave band analysis. Likewise with whole body advanced settings, 1/3 octave band is enabled for engineering analysis. If you do not plan to use the filter analysis option, you would select either "Hand Arm" or "Whole Body" from the saved setups box.*

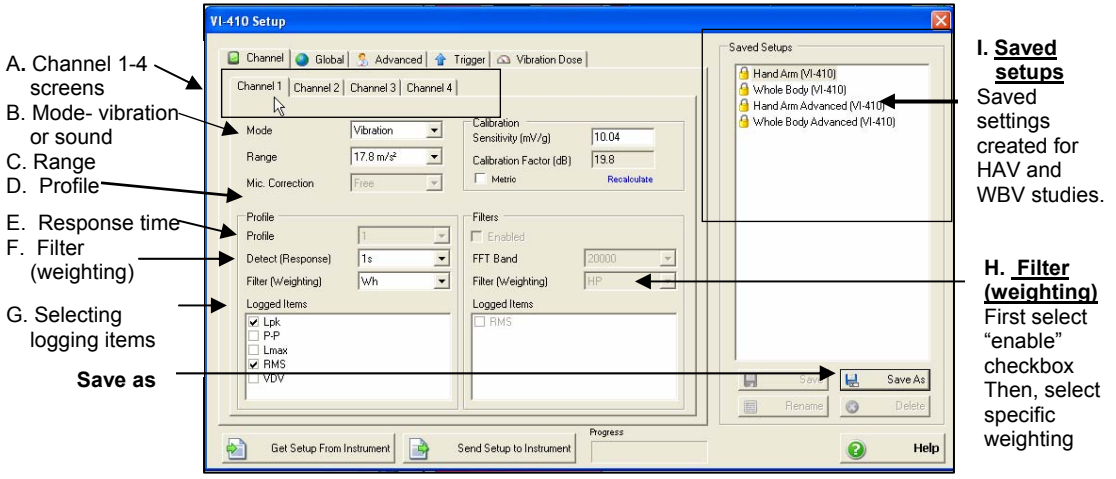


Figure 9-3: Explanation of channels setup for HAV/WBV study

1. In the Channel 1 (or x-axis) setup screen, choose the appropriate features (as explained in Table 9-1below) by using the drop down arrows or clicking in applicable checkboxes.

To change channels 2-4 setup options, click on each channel screen and select the appropriate features (see "A" in Figure 9-3 above).

2. To continue changing setup features, please see next section, "Setting up global settings".
3. Or to save settings, click on **Save As** key and name your new setup. Then see, "Send setup to instrument" for the next step.

The following table explains the measurement selections, logging options, and filter options used to setup WBV or HAV testing (Sound testing is discussed in Chapter 8).

Setup Channel screen	Explanation
A. Channel tab	Used to customize each channel (also called "axis") with various features. The default is set where channel 1 is equivalent to x-axis, channel 2 is the equivalent to y-axis, channel 3 is equivalent to z-axis, and channel 4 is equivalent to sound level mode.
B. Mode	Select either Vibration level meter (referred to as VLM) or Sound Level meter (SLM) for your study.
C. Range	The range is determined by two settings: 17.8 m/s^2 or 316 m/s^2 • ***To select Range*****,** click on the drop down arrow and click on the appropriate setting.
D. Mic. Connection	Used in Sound Level Measurement only (Discussed in Chapter 8).
E. Profile section	You can create up to three profiles per channel by setting different Detect /Response time and/or different Filters. 1. Profile ~ The profile mode enables you to select profile 1, 2, and/or 3 for a complex study of up to 3 profiles per channel. For example, you may want to study the vibration on channels 1-3 with a weighting value of HP and also weighting value of Wk • ***To select Profile****,* click on the drop down arrow and click on the appropriate profile. 2. Detect (Response Time) ~ enables you to detect vibration in seconds or milliseconds. You have the following options: 100 ms, 125 ms, 200ms, 500 ms or 1s, 2s, 5s, 10s • ***To select Detect,*** click on the drop down arrow and click on the appropriate response time. 3. Filter (Weighting) ~ used for different types of vibration analysis. (Please see Appendix A for explanation of the types of filter weightings) • ***To select Filter****,* ensure that you have selected either HAV advanced or WBV advanced . In the channel tab, click on the drop down arrow and select a filter. Continue to click on each channel and apply a filter and weighting as needed.

Table 9-1: Explanation of HAV or WBV setup options

Setup Channel screen	Explanation
F. Logged items	You can setup logged items (also called "Logger" on the instrument) to display the following measurements: • Lpk, RMS, P-P, Lmax, or VDV ➢ ***To select Logged items*** click in the checkboxes to activate. (A checkmark indicates "activated" .)
G. Calibration	Once each channel is calibrated in the field (see Chapter 4 for details), the calibration value is entered into this field.
H. Filter section (for octave band analysis)	Frequency filters provide detailed results to identify the causes of vibration and enable you to develop corrective engineering and administrate changes. ➢ ***To enable a filter***, click on either the **hand arm advanced** or **whole body advanced** under saved settings (see figure 3-5 for reference of Saved Settings). Next, click in the Enable filters box and select a type of filter from the drop down box.
I. Saved Settings	Saved templates for HAV or WBV studies which can be modified to fit your study (ies).

Table 9-1: Explanation of HAV or WBV setup options (Continued)

Global settings

Once you have selected the channel settings (or chose one of the "saved settings" templates), the next step is to view or modify the "global settings" screen.

Measurement function

When selecting the measurement function, you have the option of selecting "Level Meter", for vibration testing or sound testing, ""1/1", "1/3", or "FFT". This feature will apply to all of the channels. (Please refer to "A" in Figure 9-4).

Measurement setup

The optional features in the measurement setup section include selecting the start delay time before a run/test, run time, and data logging rate (also called "logger step time"). (Please refer to "B" in Figure 9-4).

File Saving and Statistics

Under file option, the default setting for saving files is automatically set for auto-saving. The default study will save as "Vib" and chronologically increase with 1 through Infiniti. (For example, if you saved 4 studies, QSP-II would automatically save the files as "VIB", "VIB1, "VIB2, "VIB3"). You can rename the file by typing in up to 5 characters. QSP-II will then rename the file and

continue to add on a numerical value with each study saved. To turn on or off the statistics feature, a click in a checkbox will enable this feature.

➢ **Setting Measurement function, Measurement setup, and File setup**

1. Ensure you are in the setup screen of the VI-410.
2. Click on the **Global tab**. You will have the following options:
   - **"A" measurement function**: select either Level meter (for vibration or sound testing), 1/1 octave, 1/3 octave, or FFT.
   - "B" measurement setup: select start delay time and run time
   - **"C" Log Time**: select the logging rate in milliseconds, seconds, or minutes.
   - **"D" Autosave:** automatically enabled in QSP-II. (Uncheck if you do not wish to automatically save every study. For more details see Save Options in Chapter 3.)
   - **"E" Customize file** : type in a customized name (up to 5 character). QSP-II will then assign the name you provided and will add "1" to the first character string. Each study will save in numeric order.
   - **"F" Save statistics**: Saving statistics is used only for sound level meter (See Chapter 8).
3. To select any of global settings, click in the drop down boxes and either select from the list or type in a value/characters.
4. Once completed, either refer to the next section, **Working with Advanced tab in QSP-II**.
   - **Or** Save your settings by selecting the Save As key and name your setup. Then see, **Send setup to instrument.**

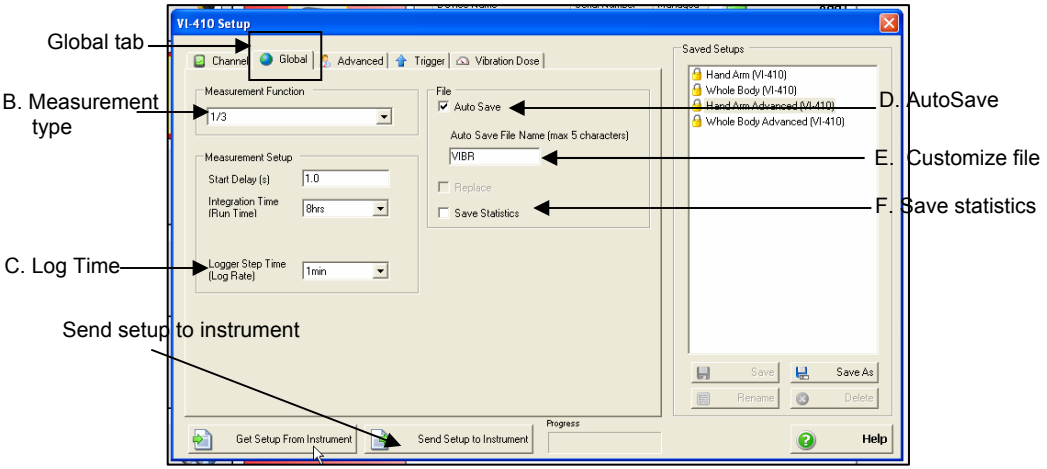


Figure 9-4: Selecting Global settings during setup

Working with Advanced setup features

- ***Working with Advanced tab in QSP-II -*** this includes defining the reference level setup, external input or external output feature, input type, and explaining the vector coefficient option.
- ***Working with Trigger Mode***- an explanation of the triggering function and how to set the various settings.
- ***Working with the Vibration dose functions*** - an explanation of how to change the default European standards. It will also explain how to customize the naming convention of the x-axis, y-axis, and z-axis.

Advanced settings in QSP-II

Below explains how to customized advanced settings including changing the reference level, selecting an external input/output mode, selecting linear or exponential, and changing vector coefficient (if applicable).

1. From the VI-410 setup key, click on the Advanced tab.
2. In the Advanced screen, either type in the appropriate setting or select one of the drop down choices.
3. When completed, either save your settings and send to the instrument or see the next section, “Triggering”.

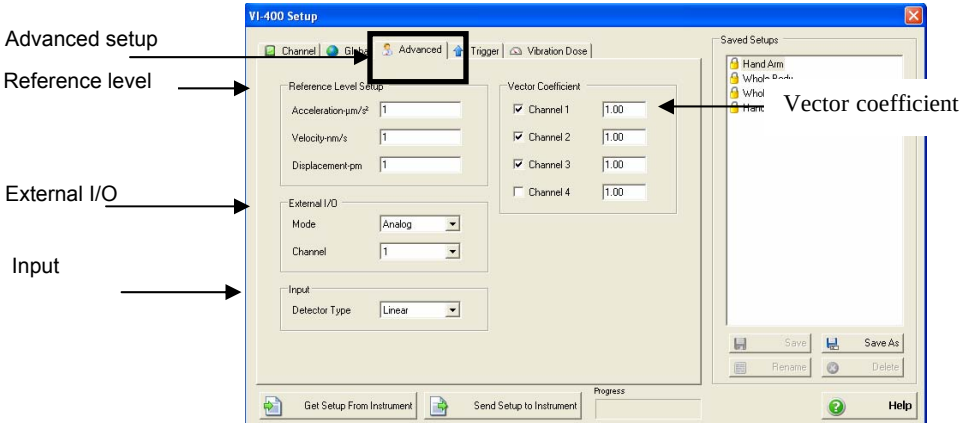


Figure 9-5: Explaining Advanced setup tab for HAV

Setting up Triggering in QSP-II

The instrument can be set to operate in a trigger mode. Triggering can take the place of the manual use of Starting a study (Start/Stop key) and Stopping a study (Start/Stop key). It can also be used to monitor runs with specific vibration values or sound pressure levels in relation to set points. (Please see Chapter 3, "Triggering" for description of selectable fields.)

✍ ***NOTE:*** *When activating the triggering mode for vibration level studies, the "triggering signal" is the signal coming form the RMS detector of the first channel.*

Slope+ or Slope-

When the ***Slope+*** mode is selected, the measurement starts when the signal increases past a specified **signal source** (i.e., vector value) and a specified vibration value (also called **VLM level**). It will continue to store measurement values until the "run time" (also called integration time) is reached or if you manually stop the study. The default for the "run time" value is set at 8 hours (see Figures 3-13 and 3-14 below)

When the ***Slope-*** mode is selected, the measurement starts when the signal decreases past a specified signal source and a specified vibration value and will continue store measurement values until run time is reached or if you manually stop the study.

The figure below displays an example of selecting "Slope+" as the *triggering mode*, selection of "maximum" measurement value for the *signal source*, and the vibration level as "8" for HAV study. In essence, this example demonstrates if the maximum value exceeds 8 m/s^2 for HAV study, then the instrument would begin storing that specific data.

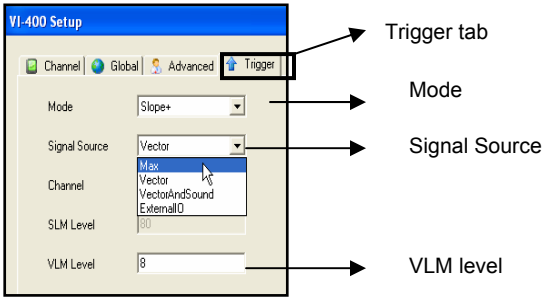


Figure 9-6: Example of setting the trigger for "slope+" mode

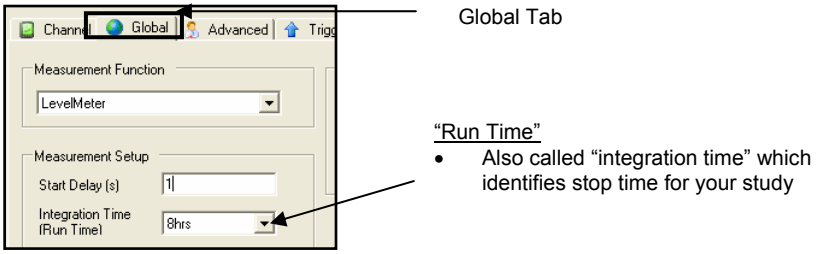


Figure 9-7: Example of where stop time is set for triggering mode

Setting Slope+ or Slope– in the trigger mode

1. In the setup screen, click on the **Trigger tab**.
2. In the **Mode** drop down box, select either Slope + or Slope -.
3. In the **Signal Source** field, select one of the measurement values by clicking on the drop down box and clicking the appropriate value.
4. In the **VLM** mode, 80 will appear. You can adjust this by typing a numeric value in the VLM field.
5. If you want to adjust the "stop" triggering time, click on the global tab, and select a new "run time" (see Figure 3-14 above).
6. Either continue to change/modify the settings or click on the Save As key to save the setup. (See "sending settings to instrument" when your setup is complete.)

Level+ or Level-

- When the **Level +** mode is set, the triggering condition is checked each second; the measurement is saved only when the signal is ***greater than*** the signal source level and in any other cases the measurement result is not stored.
- When the **Level -** mode is set, the triggering condition is checked each second; the measurement is saved only when the signal is ***less than*** the signal source level and in any other cases the measurement result is not stored.

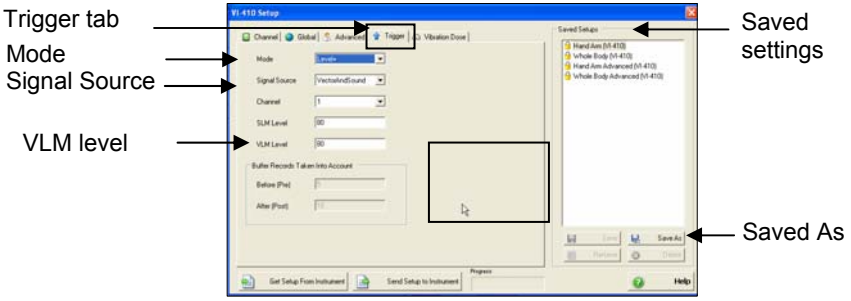


Figure 9-8: Trigger setting with Level+ mode

Setting trigger mode with Level + or Level –

1. In the setup screen, click on the Trigger tab.
2. In the **Signal Source** field, select one of the measurement values by clicking on the drop down box and clicking the appropriate value.
3. In the **VLM** mode, 80 will appear. You can adjust this by typing a numeric value in the VLM field.
4. If you want to adjust the “stop” triggering time, click on the global tab, and select a new “run time”.
5. Either continue to change/modify the settings or click on the Save As key to save the setup. (See “ending settings to instrument” when your setup is complete.)

Logger

In the buffer trigger mode, a pre and post logging rate is specified. If the logging rate is set at 15 second intervals for the pre and post intervals, for example, the buffer will look at all the measurements and store only the study time 15 seconds before and 15 seconds after the study.

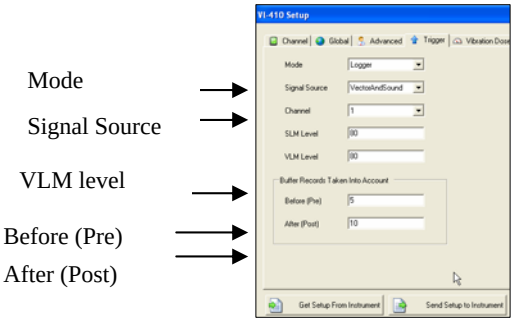


Figure 9-9: Trigger setting with logger mode

1. In the setup screen, click on the Trigger tab.
2. In the **Mode** drop down box, select Buffer.
3. In the **Signal Source** field, select one of the measurement values by clicking on the drop down box and clicking the appropriate value.
4. In the **VLM** mode, 80 will appear. You can adjust this by typing a numeric value in the VLM field.
5. To set pre logging rate, type in the appropriate value (i.e., 15 sec.)
6. To post logging rate, type in the appropriate value (i.e., 15 sec).
7. Either continue to change/modify the settings or click on the Save As key to save the setup. (See “sending settings to instrument” when your setup is complete.)

Working with the Vibration dose functions

In the Vibration dose screen, you can modify the default European standard, (noted as UK in QSP-II). You can also customize the x-axis, y-axis, and z-axis as it pertains to Channel 1, Channel 2, and Channel 3, or Channel 4.

Setting instrument standard and exposure time

1. From the S**etup** main menu, ensure you selected either **hand arm** or **whole body** setup under “saved settings”.
2. Click on the **Vibration Dose** tab.
3. To change the standards, click in the **Standard** drop down box and select **Italy, Poland, or user**.
4. The **exposure time** is automatically set at 8 hours. A different time can be inputted by using the up and down arrows in the Exposure time field to change the default time.
5. Either continue to change/modify the settings or click on the Save As key and name your new setting. (See “sending settings to instrument” to proceed to the next section.)

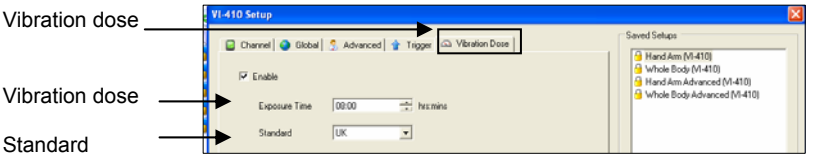
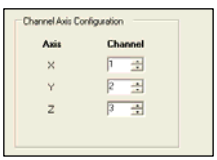


Figure 9-10: Defining exposure time and instrument standard

Changing the axis setup/configuration

The axis setup is configured where the x-axis refers to channel 1, the y-axis refers to channel 2, the z-axis refers to channel 3, and channel 4 is setup for sound testing. This can be changed to any variation in the Vibration Dose of the setup menu.



1. From the **Setup** main menu, ensure you selected either **hand arm** or **whole body** setup under “saved settings”.
2. Click on the **Vibration Dose** tab.
3. Using the **up/down arrows** in the channel axis configuration section, you can change each of the axis one by one.
4. Either continue to change/modify the settings or click on the Save As key and name your new setting.

Sending Settings from QSP-II to VI400Pro

After selecting a saved setting or making modifications to the setup parameters, you can send these new changes to the VI-410. Below explains the steps.

1. Using the **USB cable**, plug it into the instrument (Figure 9-11A) and then connect the instrument to your computer (Figure 9-11B). Ensure that the VI-410 is in the "**On**" position.
   - (To turn on VI-410, simultaneously press the **Proceed/Pause** key and **Start/Stop** key.)

A. Connect USB to instrument

B. Connect USB to your pc

Figure 9-11: Connecting the instrument (A) to the pc (B)

2. In QSP-II for the VI-410 instrument, select the instrument from the menu and click on the **Setup** key.
3. Select the appropriate setup in the Saved Settings. (i.e., hand arm advanced or one of your customized setups.)
4. From the setup screen, click on the **Send Setup to Instrument** key.

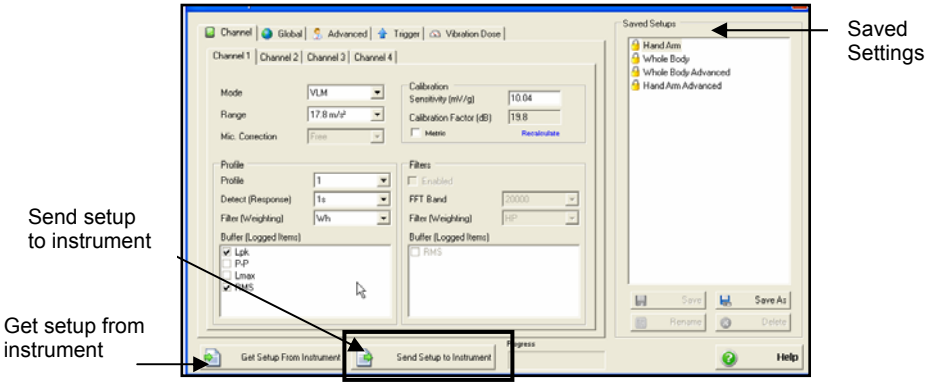


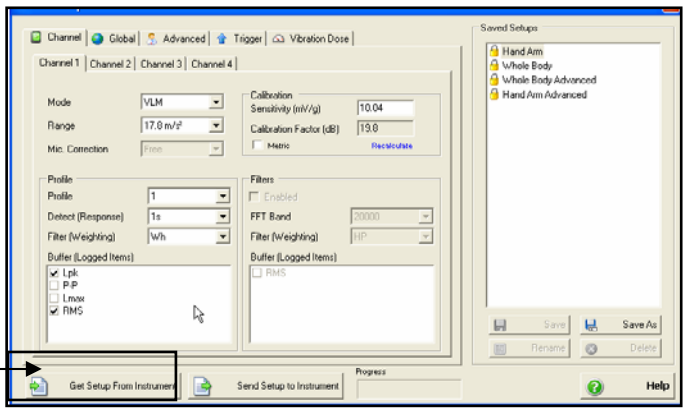
Figure 9-12: Sending setup to/from instrument

✍ ***NOTE***: *The instrument will show a progress bar*  *and it will state, "data successfully sent to unit" once it is complete.*

Get setup from instrument

As mentioned above, you can customize your setup parameters and then when you are ready, you can then pull the modified setup to QSP-II. Below explains the steps.

1. Using the USB cable, connect the instrument to your computer. Ensure that the VI-410 is in the "On" position.
   - (To activate, simultaneously press the Proceed/Pause key and **Start/Stop** key.)
2. In QSP-II for the VI-410 instrument, select the instrument from the menu and click on the Setup key.
3. In the setup screen, click on **Get setup from instrument**



Get setup from instrument

Figure 9-13: Get setup from instrument

Data

Retrieve data from VI-410 to QSP-II

Once you have conducted a vibration study (or studies) in the field, you can retrieve the data (or export the data) from the VI-410 to your QuestSuite Professional II software.

1. While the VI-410 is in the "On" position, plug the USB cable into the VI-410 and connect this to your pc.

2. Open up QSP-II software and under **My Instruments** click on **Vibration** (for vibration instruments). Then click on **VI-410** and select **Retrieve Data** (see Figure 9-14).

✍ ***NOTE:*** *If you select Vibration tab and then click on Retrieve Data, the software will automatically detect the instrument. It is optional to choose Vibration tab and then select VI-410 icon.*

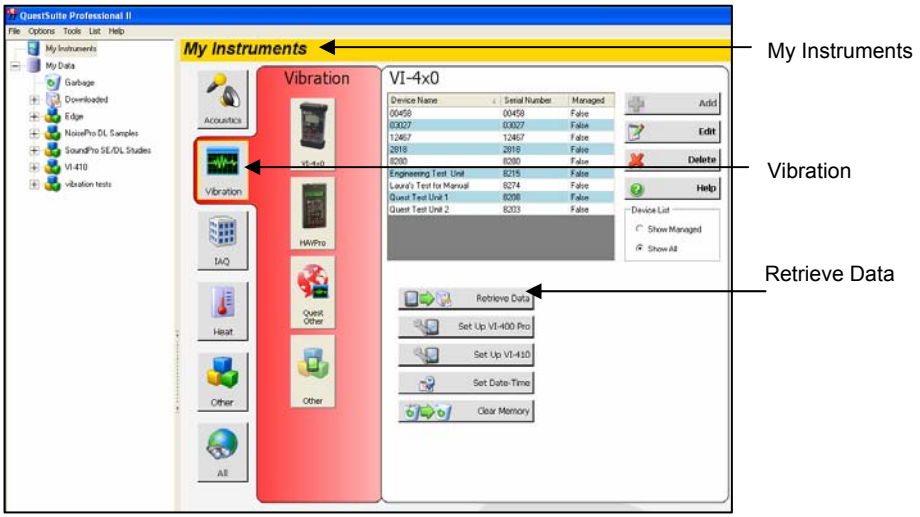


Figure 9-14: Retrieve data key in QSP-II

3. In the **Retrieve Data** dialog box, click on **Select All** or select specific instrument data by clicking in specific checkboxes. Next, click **Download** key.

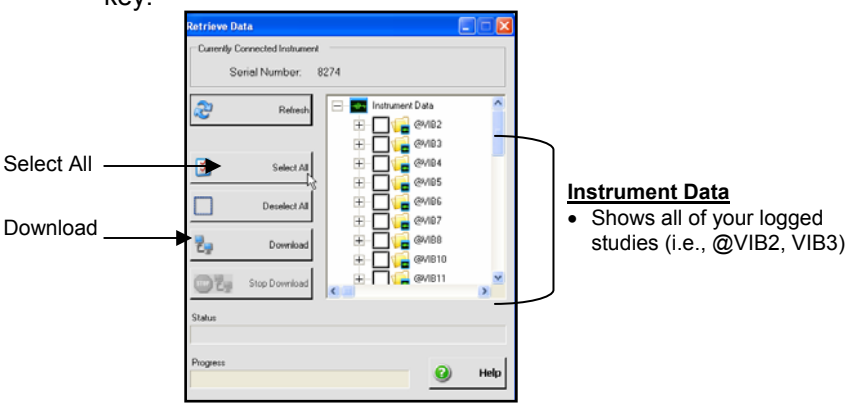
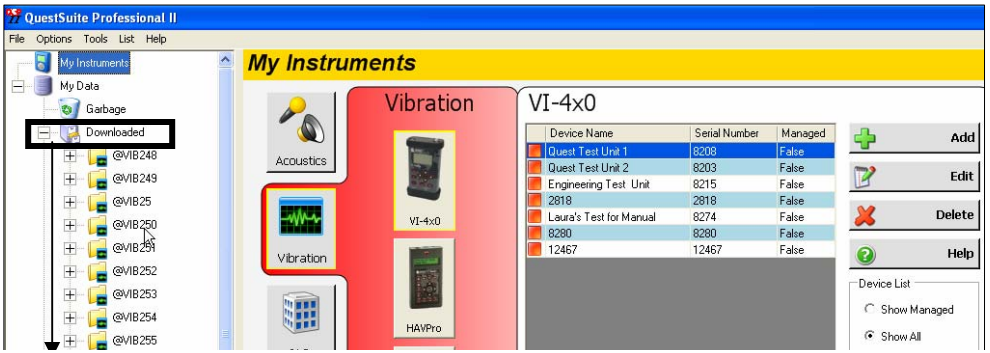


Figure 9-15: Retrieve data dialog box

4. Once it is downloaded, you will get a message stating "Download Complete". Click on the "**X**" to **close** the dialogue box.

Viewing studies in QSP-II

In Chapter 1, you were introduced to the logon screen of QSP-II. Remember that "My Instruments" is used to manage your vibration instrument including setup and retrieving studies. The "Downloaded" Node (left-hand side of screen) lists all of your logged sessions.



Downloaded node

- Click on Downloaded and then click the "+" to expand the tree view.
- It will reveal the Session, Meter configuration (same as your set-up parameters), and Study data

Figure 9-16: Accessing your studies/sessions from QSP-II

1. In the **Tree Nodes**, click on **Downloaded** to expand the node.
   - Ensure that you "retrieved data" or downloaded data from instrument to software. (See "Retrieved logged data from VI-410 to QSP-II" above).

2. Click on the appropriate **session** you wish to view. (The session will expand out into studies.) If you want to view the study level, click on the session (yellow folder) and it will expand into a study. (A red book icon indicates a study).

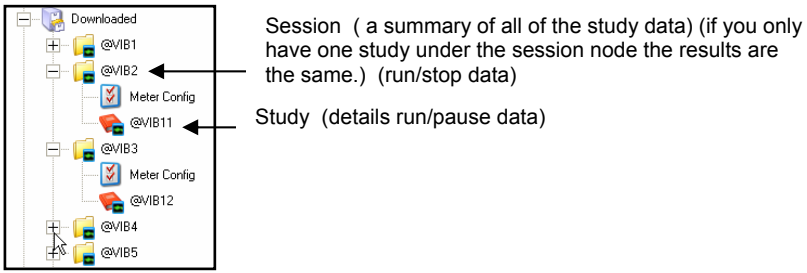


Figure 9-17: Downloaded studies

3. On the right-hand side of QSP-II, your data is displayed in graphs and charts. (For more details see online help in QSP-II.)

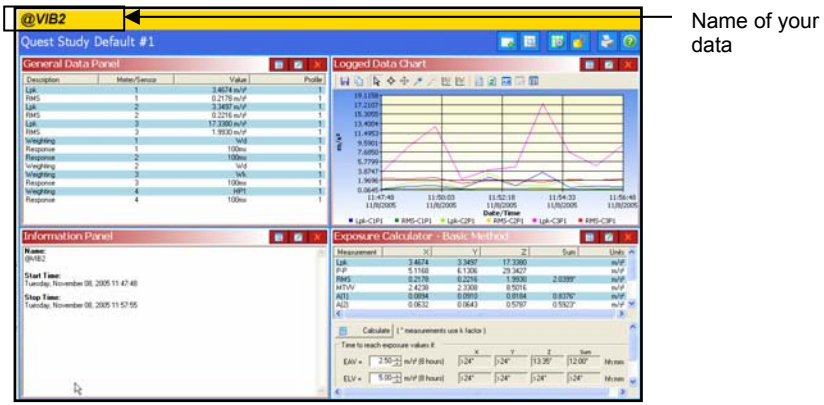


Figure 9-18: Viewing your results in charts and graphs

Tables and charts layout view

You can add, edit, print, and export data in QSP-II. The following diagram illustrates the main features and menu bars in QSP-II.

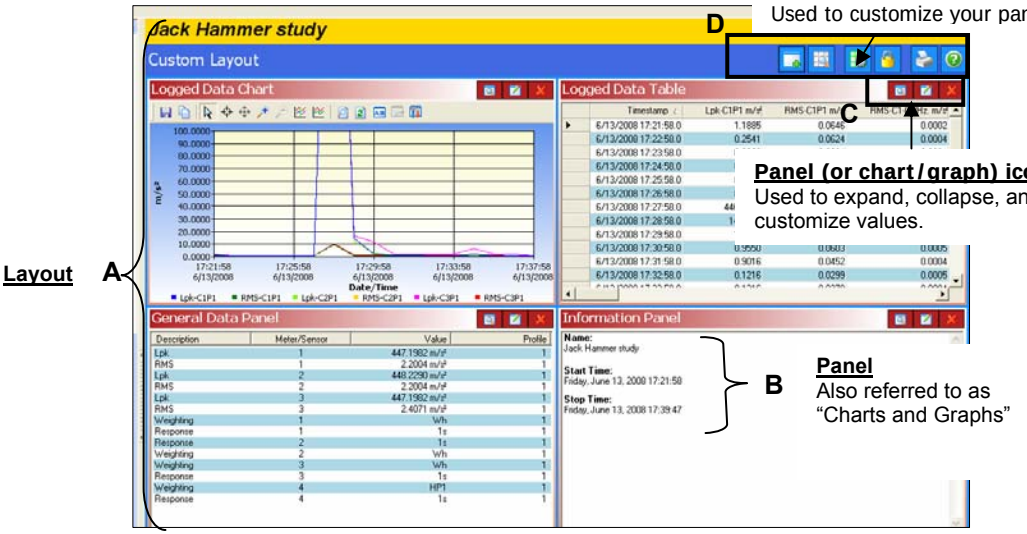


Figure 9-19: example of QSP-II measurement results (layout view)

Graphs & Charts	Explanation of layout view
A. Layout	QSP-II is divided into two panes (or sections). One is the layout view and the second pane is the "control pane". The layout is divided into "panels" which contain charts and graphs, calibration history, etc. You can add charts and/or graphs (by adding panels), move them in the appropriate position, and/or customize the data values.
B. Panel	For the VI-410, the standard layout (or default template) has three panels. The panels can be moved, edited, and expanded or collapsed. (see "Chart and Graph icons)
C. Chart & Graph icons	Used to enlarge or hide a panel (also called chart or graph), edit the data, or close the view. ☑ Expand or Collapse the panel (graph/chart) ☑ Edit (edit the parameters of the selected screen) ☑ Delete (closes the window)
D. Layout icon toolbar	This toolbar is used to add tables and/or charts, arrange tables or charts, manage the layout view, lock it, print reports and access to the help files.

APPENDIX A

REMOTE CONTROL

Only one serial interface, new, relatively fast, the USB in version 1.1 is used in **VI-410** instrument. This interface enables one to control remotely the unit. It works with 12 MHz clock. Its speed is relatively high and it ensures the common usage of USB in all Personal Computers produced nowadays.

The functions which are developed in order to control data flow in the serial interface ensure:

- bi-directional data transmission,
- remote control of the instrument.

The user, in order to programme the serial interface, has to:
1. send "the function code",
2. send an appropriate data file or
3. receive a data file.

A.1. Input / output transmission types

The following basic input / output transmission types (called functions) are available:

#1 input / output of the control setting codes,
#2 output of the measurement data in the sound level meter (**SLM**) or vibration level meter (**VLM**) mode,
#3 output of the measurement data in **1/1 OCTAVE** or **1/3 OCTAVE** mode,
#4 read out the data file from the internal Flash-disc and/or the special file located in the RAM memory,
#5 read out the statistical analysis results,
#6 remote setting of the user filters,
#7 special control functions,
#9 send the setup file to the internal Flash-disc.

A.2. Function #1 – input / output of the control setting codes

Function #1 enables the user to send the control setting codes to the instrument and read out a file of the current control state. A list of the control setting codes is given in Tab. A.1.

The format of **#1** is defined as follows:

#1,Xccc,Xccc,(...),Xccc; or
#1,Xccc,X?,Xccc,(...),X?,Xccc; where:
X - the group code, **ccc** - the code value,
X? - the request to send the current X code setting.

The instrument will output a control settings file for all requests **X?** in the following format:

#1,Xccc,Xccc,(...),Xccc;

In order to read out all current control settings the user should send to the device the following characters:

#1;The instrument will output a control settings file in the format:
#1,Xccc,Xccc,(...),Xccc;

Example: The following sequence of characters:

#1,U958,N4000,Z0:1,Z0:2,Z0:3,Z1:4,M3,Y1000,Xa1,Xv1,Xd1,XA0,XR0,S0;

means that:

-the **Quest VI-410** is investigated (U958),
-the unit's number is **4000** (N4000),
-the **Vibration Level Mode** is selected in channel 1 (Z0:1),
-the **Vibration Level Mode** is selected in channel 2 (Z0:2),
-the **Vibration Level Mode** is selected in channel 3 (Z0:3),
-the **Sound Level Mode** is selected in channel 4 (Z1:4),
-the **1/3 OCTAVE analyzer** function is selected (M3),
-the measurement start delay is equal to **1000** milliseconds (Y1000),
-the reference level for acceleration measurement is set to **1 µms^{-2}** (Xa1),
-the reference level for velocity measurement is set to **1 nms^{-1}** (Xv1),
-the reference level for displacement measurement is set to **1 pm** (Xd1),
-the AutoSave option is switched off (XA0),
-the RAM file will not be created (XR0),
-the instrument is in the **STOP** state (S0).

Note: *All bytes of that transmission are ASCII characters.*

Note: Any setting can be changed only when the instrument is in the STOP state (S0).

A.3. Function #2 – read-out of the measurement results in SLM or VLM Mode

Function **#2** enables one to read out the current measurement data in the **SLM** or **VLM** Mode.

Notice: *This function can also be programmed while measurements are taking place.*
*In this case, the RMS values measured **after entering #2 function** will be sent out.*

#2 function has a format defined as follows:

#2,p,X?,X?,X?,(...),X?;

where:

X - the code of the result,
p - the number of the results set
0 – for reading vibration dose results
1, 2, 3,.., 12 – for reading profile results
(calculated from the formulae: *ChannelNumber + 4 * (ProfileNumber - 1)*

Notice: *After entering the **STOP** condition, #2 function is no longer active and has to be reprogrammed in order to read-out successive measurements.*

The instrument will send the values of the results in the format defined as follows:

#2,p,Xccc,Xccc,Xccc,(...),Xccc; (where **p** - the number of the results set)

or

#2,?; (when the results are not available).

The codes of the results in the case of **SLM** mode are defined as follows:

T time of the measurement (ccc – value in seconds);
V the overload flag (ccc equals to 0 or 1);
P the **PEAK** value (ccc – the value in dB);
M the **MAX** value (ccc – the value in dB);
N the **MIN** value (ccc – the value in dB);
S the **SPL** value (ccc – the value in dB);
R the **LEQ** value (ccc – the value in dB);
U the **SEL** result (ccc – the value in dB);
B(k) the **Lden** result (ccc – the value in dB);
Y the **Ltm3** result (ccc – the value in dB);
Z the **Ltm5** result (ccc – the value in dB);
L(nn) the value **L** of the **nn** statistics (ccc – the value in dB).

Notice: *The value displayed on the screen during the result's presentation will be sent out from the instrument in the case when after the **X** code the **nn** is not given.*

Notice: *For profiles 2 and 3 the **L(nn)** result is not calculated.*

Notice: *The presented above order of the measurement results sent out by the instrument does not depend on the order of the characters sent to the unit.*

Notice: *In the case of **Lden**, the value **k** placed in the parenthesis after the code **B**, denotes the kind of the currently measured result. The kind of the **Lden***

*result depends on the time during which the measurements were performed (**d** denotes day, **e** denotes evening and **n** denotes night). The corresponding values of k parameter and the kind of the measured **Lden** result are presented below:*

***k** = 1*	***Ld** result,*
***k** = 2*	***Le** result,*
***k** = 3*	***Lde** result,*
***k** = 4*	***Ln** result,*
***k** = 5*	***Lnd** result,*
***k** = 6*	***Len** result,*
***k** = 7*	***Lden** result.*

Example: After sending to the instrument the string:

#2,1,T?,V?,B?,P?,M?,R?,L50?;

one should receive the following answer:

#2,1,T3,V0,P66.91,M64.55,R61.70,B(2)66.70,L(50)54.95;

The codes of the results in the case of **SOUND DOSIMETER** mode are defined as follows:

T time of the measurement (ccc – value in seconds);
V the overload flag (ccc equals to 0 or 1);
P the **PEAK** value (ccc – the value in dB);
M the **MAX** value (ccc – the value in dB);
N the **MIN** value (ccc – the value in dB);
S the **SPL** value (ccc – the value in dB);
D the **DOSE** value (ccc – the value in %);
d the **DOSE8h** value (ccc – the value in %);
A the **LAV** value (ccc – the value in dB);
R the **LEQ** value (ccc – the value in dB);
U the **SEL** result (ccc – the value in dB);
u the **SEL8** value (ccc – the value in dB);
E the **E** value (ccc – the value in Pa^2h);
e the **E8h** value (ccc – the value in Pa^2h);
I the **LEPd** value (ccc – the value in dB);
J the **PSEL** value (ccc – the value in dB);
Y the **Ltm3** result (ccc – the value in dB);
Z the **Ltm5** result (ccc – the value in dB);
L(nn) the value **L** of the **nn** statistics (ccc – the value in dB).

The codes of the results in the case of **VLM** mode are defined as follows:

T time of the measurement (ccc – value in seconds);
V the overload flag (ccc equals to 0 or 1);
P the **P–P** value (ccc – the value in dB);
Q the **PEAK** value (ccc – the value in dB);
M the **MTVV** value (ccc – the value in dB);
R the **RMS** value (ccc – the value in dB);
H the **VDV** value (ccc – the value in dB);
v the **VEC** value (ccc – the value in dB).

Example: After sending to the instrument the string:

#2,1,T?,V?,P?,R?;

one should receive the following answer:

#2,1,T3,V0,P76.92,R64.50;

The codes of the results in the case of **Vibration Dose** mode are defined as follows:

a the **Current Dose** value (ccc – the value in dB);
b the **Daily Dose value** (ccc – the value in dB);
c the **Current Exposure** value (ccc – the value in dB);
f the **Daily Exposure** value (ccc – the value in dB);
g the **EAV Time** value (ccc – value in seconds);
h time left to reach **EAV** value (ccc – value in seconds);
i the **ELV Time** value (ccc – value in seconds);
j time left to reach **ELV** value (ccc – value in seconds).

Example: After sending to the instrument the string:

#2,0,c?,f?,g?,h?;

one should receive the following answer:

#2,0,c-27.89,f-13.44,g172800,h172800,i172800,j172800;

Notice: *All bytes of that transmission are ASCII characters.*

A.4. Function #3 – read-out of the measurement results in 1/1 OCTAVE and 1/3 OCTAVE Mode

Function **#3** enables one to read out the current measurement data in **1/1 OCTAVE**, **1/3 OCTAVE**.

#3 function format is defined as follows:

#3,n;

where: **n** – the number of channel (1, 2, 3, or 4)

The device will respond, sending the last measured spectrum (when in STOP state) or currently measured spectrum (in RUN state) in the following format:

#3,n;<Status Byte> <LSB of the transmission counter> <MSB of the transmission counter> <data byte> (...) <data byte>

Status Byte gives the information about the current state of the instrument.

D7	D6	D5	D4	D3	D2	D1	D0

where:

D7 = 1 denotes "overload indicator",
D6 = 1 denotes "averaged spectrum",
D5 = 0 the instantaneous current result (RUN State),
= 1 the final result (STOP State),
D0 to D4 reserved bits.

Note: *The measurement result is coded in binary form as dB•100 (e.g. 34.5 dB is sent as binary number 3450).*

A.5. Function #4 – read-out of the data file from the internal Flash-disc and/or the special file located in the RAM memory

Function **#4** enables the user to read-out the data file from the internal Flash-disc memory.
The data file formats are given in Appendix B.

#4 function formats are defined as follows:

#4,0,\; the file containing the catalogue,

#4,1,FILE NAME; the file containing the measurement results or saved setup,

#4,1,FILE NAME,addr; the file containing the measurement results or saved setup,

#4,2,Bnnn; the logger file,

#4,3; the special file contained in the RAM memory (**RAMfile**),

where:

FILE NAME not longer than eight-character name,

addr is the logical address of the file in the internal Flash-disc memory,

Nnn the number of the logerr file (one or more digits - depends on requirements).

RAMfile the special name for the file contained in the RAM memory, may be used also with the format: **#4,1,RAMfile;**

Notice: The "\" character is the obligatory catalogue file name *(it must be sent to the instrument).*

The device will respond sending the specified file/catalogue in the following format:

#4,k;<4 bytes giving the file size (in binary form)><data byte>...<data byte>

where character **k** corresponds to the file type:

0 for the file containing the catalogue,

1 for the file containing the measurement results or saved setup,

2 for the file containing the logger.

All data words are sent as **<LSB>**,**<MSB>**.

When an error is detected in the file specification or data, the instrument will send: **#4,?;**

The catalogue of the files is a set of the records containing 16 words (16 bits each). Each record describes one file saved in the instrument's Flash-disc. The record structure is as follows:

words 0 - 3 8 character file name,

word 4 file type (binary number),
word 5 reserved,
word 6 least significant word of the file size,
word 7 most significant word of the file size,
word 8 least significant word of the file logical address,
word 9 most significant word of the file logical address,
word 10 measurement start date,
word 11 measurement start time,
words 12 - 15 reserved.

For loggers and the RAMfile the **logical address** is always set to 0. For files containing saved setup measurement start date and time are always set to 0.

***Notice:** If the **DEFRAGMENTATION** function is performed after the read out of the files catalogue the logical addresses of the files could be wrong.*

The measurement **start date** is coded as a word with bits:

b15 ... b3 b2 b1 b0

where:

b15 b14 b13 b12 b11 b10 b9 is a year minus 2000.
b8 b7 b6 b5 is a month (1..12),
b4 b3 b2 b1 b0 is a day (1..31).

The measurement **start time** is coded as number of seconds counted from 00:00:00 divided by 2.

The structure of the files containing the measurement results, saved setups and/or files containing logger results is described in details in Appendix B.

A.6. Function #5 – read-out of the statistical analysis results

Function **#5** enables one to read out the statistical analysis results. This function is available only for channels in sound level meter mode.

#5 function format is defined as follows:

#5,p;

where:

p the number of the channel (1, 2, 3 or 4)

or the number of channel plus 4 (5, 6, 7 or 8) for the read out of the statistics in **1/1 OCTAVE** or **1/3 OCTAVE** analysis.

Notice: *Statistical analysis is always performed in profile 1.*

The device will respond, sending the current statistics in the following format:

#5,p;<Status Byte> <LSB of the transmission counter> <MSB of the transmission counter> <NofClasses><BottomClass><ClassWidth><Counter of the class> (...) <Counter of the class>

Status Byte gives the information about the current state of the instrument.

D7	D6	D5	D4	D3	D2	D1	D0

where:

D7 = 1 denotes "overload indicator",
D6 = 1 reserved,
D5 = 0 the instantaneous current result (RUN State),
= 1 the final result (STOP State),
D0 to D4 reserved bits.

Notice: *There is not any succeeding transmission in the case when the* ***Status Byte*** *is equal to 0.*

The **transmission counter** is a two-byte word denoting the number of the remaining bytes to be transmitted. Its value is calculated from the formulae:

Transmission counter = 6+n * (4 * the number of the classes in the histogram)

where:

n the number of the transmitted histograms. For p = 1, 2, 3 or 4 only one histogram is transmitted (n = 1). For p between 5 and 8 the number of the transmitted histograms depends on the measurement function and
- in the case of **1/1 OCTAVE** analysis n is equal to the number of the analysis results (NOct – cf. App. B) plus the number of the TOTAL values for this type of analysis (NOctTot);

– in the case of **1/3 OCTAVE** analysis n is equal to the number of the analysis results (NTer – cf. App. B) plus the number of the TOTAL values for this type of analysis (NTerTot);

NofClasses is a two-byte word denoting the number of classes in the histogram.

BottomClass is a two-byte word denoting the lower limit of the first class (*10 dB).

ClassWidth is a two-byte word denoting the width of the class (*10 dB).

Counter of the class is a four-byte word containing the number of the measurements belonging to the current class.

Notice: *The bytes in the words are sent according to the scheme <LSByte>..<MSByte>.*

A.7. Function #6 – remote setting of the user filters

Function **#6** enables one to send to the instrument the coefficients of the user filters.
In the available formats description of **#6** functions the following symbols are used:

type	- 0 for the vibration filters, - 1 for the acoustic filters,
name, **name$_1$**, **name$_2$**	- filter names given by the user,
v	- real type value, expressed in [dB],
first	- integer type value (number of the coefficient in the user filter),
pos	- integer type value (Total value number),
avd	- for the vibration filters: 0 - Acc, 1- Vel, 2 - Dil, - for the acoustic filters this parameter is always equal to 0,
cal	- the calibration coefficient given as the real number expressed in [dB].
chn	- channel number (1, 2, 3 or 4).

#6 function formats are defined as follows:

#6,type,L;

This function returns the list of the defined (existing in the instrument) filters in the following format: **#6,type,n,name$_1$, ... ,name$_n$;**

#6,type,W,name,v,v,...,v;

This function sets the coefficients of the new user filter named as **name**. The **name** parameter should be unique (in the instrument there is not any other filter with the same name, otherwise it will be an error). The function answers in the format: **#6;**

#6,type,R,name;

This function returns the coefficients of the user filter named as **name**. If the **name** filter does not exist, an error occurs. The function returns in the following format: **#6,type,n,v$_1$,v$_2$, ... ,v$_n$;**

#6,type,D,name;

This function deletes from the instrument the user filter named as **name**. If the **name** filter does not exist, an error occurs. The function answers in the format: **#6;**

#6,type,S,name,v,v,...,v;

This function sets the user filter named as **name**. If the **name** filter already exists, its coefficients are redefined. If the **name** filter does not exist, filter is created. The function answers in the format: **#6;**

#6,type,C,name,first,v,v,...,v;

This function sets the coefficients in the user filter named as name starting from the first position.
If the **name** filter does not exist, an error occurs. The function answers in the format: **#6;**

#6,type,N, name$_1$, name$_2$;

This function changes the name of the user filter from **name$_1$** to **name$_2$**. The function answers in the format: **#6;**

#6,type,@,chn,L;

This function returns the names of the user filters, assigned to the channel **chn** consecutive **TOTAL** values, in the following format: **#6,type,chn,3,name$_1$,name$_2$,name$_3$;**

#6,type,@,chn,pos,?;

This function returns the description record of the user filter assigned to the **pos TOTAL** value of channel **chn** in the following format: **#6,type,@,chn,pos,name,avd,cal;** (the description record contains: the name of the filter, its type and the calibration coefficient).

#6,type,@,chn,pos,*;

This function recovers the predefined filter for the **pos TOTAL** value of channel **chn** and returns the following format: **#6,type,@,chn,pos,name,avd,cal;**

#6,type,@,chn,pos,name,avd,cal;

This function sets the description record of the user filter assigned to the **pos TOTAL** value of channel **chn** in the following format: **#6,type,@,chn,pos,name,avd,cal;**

The returned parameters: **name**, **avd** and **cal** are set in the description record after the execution of the function. In the case of an error they can differ from the current parameters of the function.

Notice: *In the case of an error all these functions return the following sequence of the characters:* ***#6?;***

A.8. Function #7 – special control functions

Function **#7** enables the user to perform special control functions. **Some of them should be used with the extreme care.**

#7 function formats are defined as follows:

#7,CB;

This function clears the internal logger memory - all logger files will be deleted. The function returns **#7,CB;** This function is not accepted while the instrument is in the RUN state.

#7,BF;

This function returns logger memory free space in the format:
#7,BF,ddddd; (**ddddd** - number of bytes in decimal format).

#7,BN;

This function returns the number of logger files created to the current time in the format: **#7,BN,ddddd;** (**ddddd** - number of logger files in decimal format).

#7,RT;

This function returns current real time clock settings in the format:

#7,RT,hh,mm,ss,DD,MM,YYYY;

where **hh:mm:ss** denotes the time and **DD/MM/YYYY** gives the date.

#7,RT,hh,mm,ss,DD,MM,YYYY;

This function sets the current real time clock and returns the following sequence of characters: **#7,RT;**

#7,AS;

This function returns current real time and date settings for the AutoStart function in the format: **#7,AS,e,hh,mm,ss,DD;** where e=1 if AutoStart function is switched ON or 0 if it is switched OFF, **hh:mm:ss** gives the time and **DD** gives the day for the current date.

#7,AS,e,hh,mm,DD;

This function uses the given time and date settings for AutoStart function and returns the following sequence of characters: **#7,AS;**

#7,SS;

This function saves the current settings of the instrument in the EEPROM memory. The function returns the following sequence of characters: **#7,SS;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DA;

This function deletes all files containing measurement results and instrument's settings from the internal flash memory. The function returns the following sequence of characters: **#7,DA;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DF;

This function deletes all files containing measurement results from the internal flash memory. The function returns the following sequence of characters: **#7,DF;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DF,fileName;

This function deletes file named **fileName** containing measurement results from the internal flash memory. The function returns the following sequence of characters: **#7,DF;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DF,fileName<iAddr;

This function deletes file located at internal address **iAddr** containing measurement results from the internal flash memory. The function returns the following sequence of characters: **#7,DF;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DS;

This function deletes all files containing instrument's settings from the internal flash memory. The function returns the following sequence of characters: **#7,DS;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DS,fileName;

This function deletes file named **fileName** containing instrument's settings from the internal flash memory. The function returns the following sequence of characters: **#7,DS;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,DS,fileName<iAddr;

This function deletes file containing instrument's settings located at internal address **iAddr** from the internal flash memory. The function returns the following sequence of characters: **#7,DS;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,AN,FName;

This function sets the name of the file for the Autosave function as the **Fname**. The given name has to start with the '@' character and contain no more than 8 characters. The function returns the following sequence of characters: **#7,AN;**

This function is not accepted and not performed while the instrument is in the RUN state.

#7,AN;

This function returns current file name used by Autosave function in the format: **#7,AN,Fname;**.

This function is not accepted and not performed while the instrument is in the RUN state.

#7,AV;

This function returns analyzer firmware version in the format **#7,AV,XX.XX.XXC;** where XX.XX.XX is firmware version, C – firmware subversion.

#7,BS;

This function returns battery charge level in the format **#7,BS,nn;** where nn is a percent value. When battery state is not available (i.e. unit is powered from external source) function returns: **#7,BS,-1;**.

Notice: *For the unknown function and/or in the case of the other error, all these functions return the following sequence of characters:* ***#7,?;***

A.9. Function #9 – writing setup files to the internal Flash-disc

Function #9 allows uploading files containing instrument setup to the internal Flash-disc.
The function expects files in format described in Appendix B, paragraph B.9. **Function should be used with extreme care.**

The #9 function format is defined as follows:

#9,2,Len,<data byte> ... <data byte>

where:

Len - length of transferred file in bytes as ASCII,
<data byte> - byte of data in binary form.

Function responds with "**#9,1;**" on success and with "**#9,0;**" on failure.

A.10. Control setting codes

The control setting codes used in the **VI-410** instrument (starting from the internal software version 3.6.1) are given in the table below.

Table A.1. Control setting codes

Group name	Group code	Code description
Unit type	**U**	U958 (read only)
Serial number	**N**	Nxxxx (read only)

Software version number * 100	**W**	WLxxx xxx - Meter version numb. * 100 (read only) Wxxx xxx - Analyzer vers. numb. * 100 (read only)
Microphone field correction	**H**	H0:n - **Free** field in channel n H1:n - **Diffuse** field in channel n
Channel mode	**Z**	Z0:n - Vibration Level Meter/Analyzer for channel n Z1:n - Sound Level Meter / Analyzer for channel n
Calibration factor	**Q**	Qnnnn:c nnnn - real number with the value of the calibration factor for channel c in dB ∈(-99.9 ÷ 99.9)
Measurement function	**M**	M1 - **Level Meter** M2 - **1/1 OCTAVE analyzer** M3 - **1/3 OCTAVE analyzer** M4 - **Sound dosimeter** M6 - **FFT analyzer**
Execution of **1/1 OCTAVE**, **1/3 OCTAVE** or **FFT** analysis in channel n	**e**	e0:n - Spectrum analysis in channel n disabled e1:n - Spectrum analysis in channel n enabled
Range of channel n	**R**	R1:n - **105 dB** (**SLM**) or **17.8 ms^{-2}** (**VLM**) R2:n - **130 dB** (**SLM**) or **316 ms^{-2}** (**VLM**)
Displayed results	**P**	P1 - **CHANNEL 1, PROFILE 1** (read only) P2 - **CHANNEL 2, PROFILE 1** (read only) P3 - **CHANNEL 3, PROFILE 1** (read only) P4 - **CHANNEL 4, PROFILE 1** (read only) P5 - **CHANNEL 1, PROFILE 2** (read only) P6 - **CHANNEL 2, PROFILE 2** (read only) P7 - **CHANNEL 3, PROFILE 2** (read only) P8 - **CHANNEL 4, PROFILE 2** (read only) P9 - **CHANNEL 1, PROFILE 3** (read only) P10- **CHANNEL 2, PROFILE 3** (read only) P11 - **CHANNEL 3, PROFILE 3** (read only) P12 - **CHANNEL 4, PROFILE 3** (read only)
Filter type in profile for **SLM**	**F**	F1:m **LIN** filter for profile m F2:m **A** filter for profile m F3:m **C** filter for profile m F4:m **G** filter for profile m m = ChannelNo + 4 * (ProfileNo – 1)

Filter type in **1/1 OCTAVE** or **1/3 OCTAVE** analysis in channel n for **SLM**	**f**	f0:n - **HP** filter in channel n f1:n - **LIN** filter in channel n f2:n - **A** filter in channel n f3:n - **C** filter in channel n
Filter type in **FFT** analysis in channel n for **SLM**	**j**	j0:n - **HP** filter in channel n j1:n - **LIN** filter in channel n j2:n - **A** filter in channel n j3:n - **C** filter in channel n
Filter type in **1/1 OCTAVE** or **1/3 OCTAVE** analysis in channel n for **VLM**	**i**	i0:n - **HP** filter in channel n (read only)
Filter type in **FFT** analysis in channel n for **VLM**	**k**	k0:n - **HP** filter in channel n (read only)
Filter type in profile for **VLM**	**l**	l1:m **HP1** filter for profile m l2:m **HP3** filter for profile m l3:m **HP10** filter for profile m l4:m **Vel1** filter for profile m l5:m **Vel3** filter for profile m l6:m **Vel10** filter for profile m l7:m **VelMF** filter for profile m l8:m **Dil1** filter for profile m l9:m **Dil3** filter for profile m l10:m **Dil10** filter for profile m l15:m **KB** filter for profile m l16:m **Wk** filter for profile m l17:m **Wd** filter for profile m l18:m **Wc** filter for profile m l19:m **Wj** filter for profile m l20:m **Wm** filter for profile m l21:m **Wh** filter for profile m l22:m **Wg** filter for profile m l23:m **Wb** filter for profile m m = ChannelNo + 4 * (ProfileNo – 1)
Detector type in profile for **SLM**	**C**	C0:m - **IMPULSE** detector in profile m C1:m - **FAST** detector in profile m C2:m - **SLOW** detector in profile m m = ChannelNo + 4 * (ProfileNo – 1)

Detector type in profile for **VLM**	**E**	E0:m - **100 ms** detector in profile m E1:m - **125 ms** detector in profile m E2:m - **200 ms** detector in profile m E3:m - **500 ms** detector in profile m E4:m - **1 s** detector in profile m E5:m - **2 s** detector in profile m E6:m - **5 s** detector in profile m E7:m - **10 s** detector in profile m m = ChannelNo + 4 * (ProfileNo – 1)
Logger type in profile in the case of **SLM**	**B**	B0:m - **None** logger in profile m Bxx:m - xx – sum of values for profile m: 1 – logger with **PEAK** values 2 – logger with **MAX** values 4 – logger with **MIN** values 8 – logger with **RMS** values m = ChannelNo + 4 * (ProfileNo – 1)
Storing the results of **1/1 OCTAVE** or **1/3 OCTAVE** analysis in channel n in logger file in the case of **SLM**	**b**	b0:n - switched off (**None**) in channel n b4:n - switched on (**RMS/LEQ**) in channel n
Storing the results of **FFT** analysis in channel n in logger file	**v**	v0:n - switched off (**none**) in channel n v4:n - switched on (**RMS**) in channel n (read only)
Logger type in profile in the case of **VLM**	**G**	G0:m - **None** logger in profile Gxx:m - xx – sum of values for profile m: 1 – logger with **PEAK** values 2 – logger with **P–P** values 4 – logger with **MAX** values 8 – logger with **RMS** values 16 – logger with **VDV** values m = ChannelNo + 4 * (ProfileNo – 1)
Storing the results of **1/1 OCTAVE** or **1/3 OCTAVE** analysis in channel n in logger file	**g**	g0:n - switched off (**none**) in channel n g4:n - switched on (**RMS**) in channel n
Logger time step	**d**	dnnnn - nnnn number in milliseconds ∈(**10**, **20**, **50**, **100**, **200**, **500**, **1000**) dnns - nn number in seconds ∈(1 ÷ 60) dnnm - nn number in minutes ∈(1 ÷ 60)

Integration time	**D**	D0 “infinite” number Dnns nn number in seconds Dnnm nn number in minutes Dnnh nn number in hours
Repetition cycle	**K**	K0 - infinity (measurement stopped when the STOP button is pressed or when remote setting S0 is received) Knnnn - nnnn number of repetitions ∈(1 ÷ 1000)
Detector type in the **LEQ** (for **SLM**) and/or **RMS** (for **VLM**) function	**L**	L0 - **LINEAR** L1 - **EXPONENTIAL**
Band of the **FFT** analysis in channel n	**r**	r1:n - **22.4 kHz** band of **FFT** analysis in channel n r2:n - **11.2 kHz** band of **FFT** analysis in channel n r3:n - **5.6 kHz** band of **FFT** analysis in channel n r4:n - **2.8 kHz** band of **FFT** analysis in channel n r5:n - **1.4 kHz** band of **FFT** analysis in channel n r6:n - **700 Hz** band of **FFT** analysis in channel n r7:n - **350 Hz** band of **FFT** analysis in channel n r8:n - **175 Hz** band of **FFT** analysis in channel n r9:n - **87.5 Hz** band of **FFT** analysis in channel n
Lines in **FFT** analysis in channel n	**u**	u0:n - **1920** lines in channel n u1:n - **960** lines in channel n u2:n - **480** lines in channel n
Window in the **FFT** analysis in channel n	**w**	w0:n - **HANNING** in channel n w1:n - **RECTANGLE** in channel n w2:n - **FLAT TOP** in channel n w3:n - **KAISER–BESSEL** in channel n
Averaging in the **FFT** analysis in channel n	**a**	a0:n - **LINEAR** in channel n
Trigger Mode (TriggerMode)	**m**	m0 - **OFF** m1 - **SLOPE +** m2 - **SLOPE –** m3 - **LEVEL +** m4 - **LEVEL –** m5 - **LOGGER** m6 - **GRAD +** m7 - **RTC**

Source of the triggering signal for measurement functions: M1 and M6 (TriggerSource)	**s**	s0 - Vector value s1 - Vector and sound value s2 - **RMS** value from profile 1 s3 - External trigger
Channel of the triggering signal	**c**	c1 - channel 1 c2 - channel 2 c3 - channel 3 c4 - channel 4
Source of the triggering signal for measurement function M2 with the selection TriggerMode=LOGGER (TriggerOctSource)	**o**	o0 - Vector value o1 - Vector and sound value o2 - **RMS** from profile 1 value o3 - External trigger onn - nn number of the filter in **1/1 OCTAVE** spectra $\in$(8 ÷ NOct), respectively: 8 - 125 Hz, 9 - 250 Hz, ..., 15 - 16 kHz; NOct = 15 - number of filters in **1/1 OCTAVE** analysis
Source of the triggering signal for measurement function M3 with the selection TriggerMode=LOGGER (TriggerTerSource)	**t**	t0 - Vector value t1 - Vector and sound value t2 - **RMS** from profile 1 value t3 - External trigger tnn - nn filter's number in **1/3 OCTAVE** spectra $\in$ (23 ÷ NTer), respectively: 23 - 125 Hz, 24 - 160 Hz, , 45 - 20 kHz; NTer = 45 - number of filters in **1/3 OCTAVE** analysis
SLM's trigger level (TriggerLev)	**l**	lxxx - xxx level given in dB $\in$(24 ÷ 136)
VLM's trigger level (TriggerLev)	**n**	nxxx - xxx level given in dB $\in$(60 ÷ 200)
VLM's vector trigger level (VecTriggerLev)	**h**	hxxx - xxx level given in dB $\in$(60 ÷ 200)
Number of the records from the logger taken into account before the fulfillment of the triggering condition (TriggerPre)	**p**	pnn - nn number of the records taken into account before the fulfillment of the triggering condition $\in$(0 ÷ 20)
Number of the records from the logger taken into account after the fulfillment of the triggering condition (TriggerPost)	**q**	qnn - number of the records taken into account after the fulfillment of the triggering condition $\in$(0 ÷ 200)

Delay in the start of measurement	**Y**	Ynn	nn delay given in milliseconds ∈(0 ÷ 60000)
Reference level for acceleration (RefLev_a)	**Xa**	Xannn	nnn reference level for acceleration given in μms^{-2} ∈(1 ÷ 100)
Reference level for velocity (RefLev_v)	**Xv**	Xvnnn	nnn reference level for velocity given in nms^{-1} ∈(1 ÷ 100)
Reference level for displacement (RefLev_d)	**Xd**	Xdnnn	nnn reference level for displacement given in pm ∈(1 ÷ 100)
AutoSave option	**XA**	XA0 - XA1 -	switched OFF switched ON, file names are numbered
Saving results of statistical analysis	**XS**	XS0 - XS1 -	switched off switched on
Using the RAMfile instead of the flash disk while storing results with the AutoSave option switched on	**XR**	XR0 - XR1 -	switched OFF switched ON
External I/O Mode	**x**	x0 - x1 - x2 -	**AC/Int.** in **Analogue** mode **AC/Int.** in **Digital In** mode **AC/Int.** in **Digital Out** mode
External I/O Channel for analogue **AC/Int.** mode	**y**	yn -	n - channel number between 1 and 4
State of the instrument (Stop or Start)	**S**	S0 - S1 -	**STOP** **START**
Menu lock mode	**Xb**	Xb0 - Xb1 - Xb2 -	menu unlocked menu partially locked menu fully locked
Channel selection for vibration vector calculation	**XB**	XB0:n - channel n is not included in vector XB1:n - channel n is included in vector	
Channel coefficient for vector calculation	**XC**	XCxx:n - xx - value of coefficient *100 ∈(0 ÷ 200) - n - channel number	
Storing vector in logger file	**XD**	XD0 - XD1 -	switched OFF switched ON
Measurement of vibration dose	**XE**	XE0 - XE1 -	switched OFF switched ON
Vibration dose exposure time	**XF**	XFnn	nn - time in minutes ∈(0 ÷ 1440)

Vibration dose standard	**XG**	XG0 - Great Britain XG1 - Italy XG2 - Poland XG3 - French XG4 - user defined
X axis for vibration dose measurement	**XH**	XHn n - channel number (1..4)
Y axis for vibration dose measurement	**XI**	XIn n - channel number (1..4)
Z axis for vibration dose measurement	**XJ**	XJn n - channel number (1..4)
Outdoor microphone correction for channel n	**XK**	XK0:n - outdoor correction is OFF XK1:n - outdoor correction is ON
Expose time for dosimeter	**XL**	XLnn nn - time given in minutes
Criterion Time level for dosimeter	**XM**	XM0 - 80 dB XM1 - 84 dB XM2 - 85 dB XM3 - 90 dB
Threshold level for dosimeter	**XN**	XN0 - none XN1 - 75 dB XN2 - 80 dB XN3 - 85 dB XN4 - 90 dB
Exchange Rate level for dosimeter	**XO**	XOnn nn - level given in dB $\in$ [2,5]
Spectrum **MAX** store	**XT**	XT0 spectrum **MAX** switched OFF XT1 spectrum **MAX** switched ON
Spectrum **MIN** store	**Xt**	Xt0 spectrum **MIN** switched OFF Xt1 spectrum **MIN** switched ON
Trigger gradient level for **SLM**	**Xg**	Xgnn - nn – gradient level in dB/ms $\in$ [1,100]
Trigger gradient level for **VLM**	**Xh**	Xgnn - nn – gradient level in dB/ms $\in$ [1,100]
RTC trigger start time	**Xr**	Xrnn - nn – time in seconds $\in$ [0,86399]
RTC trigger step time	**Xs**	Xs0 - use integration time for step Xsnn - nn – step in seconds $\in$ [1,86400]
Funtion for Digital In **AC/Int.** mode	**XP**	XP0 - trigger pulse

Funtion for Digital Out **AC/Int.** mode	**XQ**	XQ0 - trigger pulse XQ1 - alarm pulse
AC/Int. polarization	**XU**	XU0 - positive XU1 - negative
AC/Int. active level	**XV**	XV0 - active low XV1 - active high
Vector alarm mode	**Xc**	Xc0:0 - **OFF** Xc1:0 - **SLOPE +** Xc2:0 - **SLOPE –**
Vector alarm step	**Xe**	Xe0:0 - logger step Xe1:0 - 100 ms Xe2:0 - 1 s Xe3:0 - integration period
Vector alarm level	**Xf**	Xfnnn:0 - nnn alarm level in dB*10
Profile alarm mode for **VLM**	**Xi**	Xi0:P:K - **OFF** Xi1:P:K - **SLOPE +** Xi2:P:K - **SLOPE –** P - profile number K - number of alarm in profile
Profile alarm mode for **SLM**	**Xj**	Xj0:P:K - **OFF** Xj1:P:K - **SLOPE +** Xj2:P:K - **SLOPE –** P - profile number K - number of alarm in profile
Integration period for **VLM** profile alarm	**Xk**	Xk0:P:K - logger step Xk1:P:K - 100 ms Xk2:P:K - 1 s Xk3:P:K - integration period P - profile number K - number of alarm in profile
Integration period for **SLM** profile alarm	**Xl**	Xl0:P:K - logger step Xl1:P:K - 100 ms Xl2:P:K - 1 s Xl3:P:K - integration period P - profile number K - number of alarm in profile

Profile alarm source for **VLM**	**Xm**	Xm1:P:K - **PEAK** Xm2:P:K - **P–P** Xm3:P:K - **MAX** Xm4:P:K - **MIN** Xm5:P:K - **RMS** Xm6:P:K - **VDV** P - profile number K - number of alarm in profile
Profile alarm source for **SLM**	**Xn**	Xn7:P:K - **PEAK** Xn8:P:K - **MAX** Xn9:P:K - **MIN** Xm10:P:K - **RMS** P - profile number K - number of alarm in
Profile alarm level for **VLM**	**Xo**	XoN:P:K - N – level in dB*10 P - profile number K - number of alarm in
Profile alarm level for **SLM**	**Xp**	XpN:P:K - N – level in dB*10 P - profile number K - number of alarm in
1/1 OCTAVE alarm mode for **VLM**	**XXa**	XXa0:P:K - **OFF** XXa1:P:K - **SLOPE +** XXa2:P:K - **SLOPE –** P - channel number K - number of alarm in channel
1/1 OCTAVE alarm mode for **SLM**	**XXb**	XXb0:P:K - **OFF** XXb1:P:K - **SLOPE +** XXb2:P:K - **SLOPE –** P - channel number K - number of alarm in channel
1/1 OCTAVE period for **VLM** profile alarm	**XXc**	XXc0:P:K - logger step XXc1:P:K - 100 ms XXc2:P:K - 1 s XXc3:P:K - integration period P - channel number K - number of alarm in channel

1/1 OCTAVE period for **SLM** profile alarm	**XXd**	XXd0:P:K - logger step XXd1:P:K - 100 ms XXd2:P:K - 1 s XXd3:P:K - integration period P - channel number K - number of alarm in channel
1/1 OCTAVE alarm source for **VLM**	**XXe**	XXe11:P:K - 1 Hz band ... XXe25:P:K - 16 kHz band P - channel number K - number of alarm in channel
1/1 OCTAVE alarm source for **SLM**	**XXf**	XXf11:P:K - 1 Hz band ... XXf25:P:K - 16 kHz band P - channel number K - number of alarm in channel
1/1 OCTAVE alarm level for **VLM**	**XXg**	XXgN:P:K - N – level in dB*10 P - channel number K - number of alarm in channel
1/1 OCTAVE alarm level for **SLM**	**XXh**	XXhN:P:K - N – level in dB*10 P - channel number K - number of alarm in channel
1/3 OCTAVE alarm mode for **VLM**	**XXA**	XXA0:P:K - **OFF** XXA1:P:K - **SLOPE +** XXA2:P:K - **SLOPE –** P - channel number K - number of alarm in channel
1/3 OCTAVE alarm mode for **SLM**	**XXB**	XXB0:P:K - **OFF** XXB1:P:K - **SLOPE +** XXB2:P:K - **SLOPE –** P - channel number K - number of alarm in channel
1/3 OCTAVE alarm period for **VLM**	**XXC**	XXC0:P:K - logger step XXC1:P:K - 100 ms XXC2:P:K - 1 s XXC3:P:K - integration period P - channel number K - number of alarm in channel

1/3 OCTAVE alarm period for **SLM**	**XXD**	XXD0:P:K - logger step XXD1:P:K - 100 ms XXD2:P:K - 1s XXD3:P:K - integration period P - channel number K - number of alarm in channel
1/3 OCTAVE alarm source for **VLM**	**XXE**	XXE11:P:K - 0.8 Hz band ... XXE55:P:K - 20 kHz band P - channel number K - number of alarm in channel
1/3 OCTAVE alarm source for **SLM**	**XXF**	XXF11:P:K - 0.8 Hz band ... XXF55:P:K - 20kHz band P - channel number K - number of alarm in channel
1/3 OCTAVE alarm level for **VLM**	**XXG**	XXGN:P:K - N – level in dB*10 P - channel number K - number of alarm in channel
1/3 OCTAVE alarm level for **SLM**	**XXH**	XXHN:P:K - N – level in dB*10 P - channel number K - number of alarm in channel

B.DATA FILE STRUCTURES

B.1. STRUCTURE OF THE VI-410 PRO FILE

Each file containing data from the VI-4xx Pro instrument consists of several groups of words. In the case of the **VI-410 PRO** there are some different types of files that contain:

- the measurement results from the **L**evel **M**eter mode (cf. App. B.2);
- the results from **1/1 OCTAVE** analysis (cf. App. B.3);
- the results from **1/3 OCTAVE** analysis (cf. App. B.4);
- the results from the **FFT** analysis (cf. App. B.5);
- the results from the **L**evel **M**eter mode stored in the file in the instrument's buffer (cf. App. B.6 and App. B.10);
- the results from **1/1 OCTAVE** or **1/3 OCTAVE** analysis stored in the file in the instrument's buffer (cf. App. B.7 and App. B.10);
- the results from the **FFT** analysis stored in the file in the instrument's buffer (cf. App. B.8 and App. B.10);
- the setup data of the instrument (cf. App.B.9);

Each file has the following elements:

- a file header (cf. Tab. B.1.1);
- the unit and internal software specification (cf. Tab. B.1.2);
- the marker for the end of the file (cf. Tab. B.1.25).

The other elements of the file structure are not obligatory for each file type stated above. They depend on the file type (**LM**, **1/1 OCTAVE**, **1/3 OCTAVE** or **FFT** analysis, file from the buffer, setup file). These elements are as follows:

- the parameters and global settings, common for all channels (cf. Tab. B.1.3);
- the hardware settings for channels (cf. Tab. B.1.4);
- the software settings for channels (cf. Tab. B.1.5);
- the **VECTOR** measurement settings (cf. Tab. B.1.6);
- the **1/1 OCTAVE** or **1/3 OCTAVE** analysis header (cf. Tab. B.1.7);
- the hand-arm and whole-body vibration dose measurement settings (cf. Tab. B.1.9);
- the main results (cf. Tab. B.1.10);
- the selected statistical levels in channels (cf. Tab. B.1.11);
- the results coming from **1/1 OCTAVE** analysis (cf. Tab. B.1.12);
- the results coming from **1/3 OCTAVE** analysis (cf. Tab. B.1.13);
- the totals description in 1/1 octave or 1/3 octave analysis (cf. Tab. B.1.16);
- the user defined filter description (cf. Tab. B.1.17);
- the header of the **FFT** analysis (cf. Tab. B.1.8);
- the results of the **FFT** analysis (cf. Tab. B.1.14);
- the header of the statistical analysis (cf. Tab. B.1.18);
- the results of the statistical analysis (cf. Tab. B.1.19);
- the statistical analysis results the made in **1/1 OCTAVE** or **1/3 OCTAVE** mode (cf. Tab. B.1.20);
- the buffer header (cf. Tab. B.1.22);
- the **1/1 OCTAVE** or **1/3 OCTAVE** buffer header (cf. Tab. B.1.23);
- the data stored during the measurements in the buffer (cf. Tab. B.1.24);
- the setup data of the instrument (cf. Tab. B.1.26);
- the user defined filters (cf. Tab. B.1.27);
- the results coming from rotation measurements (cf. Tab. B.1.34);
- the **SEAT** measurements settings (cf. Tab. B.1.36);
- the Max results coming from **1/1 OCTAVE** analysis (cf. Tab. B.1.37);
- the Min results coming from **1/1 OCTAVE** analysis (cf. Tab. B.1.38);
- the Max results coming from **1/3 OCTAVE** analysis (cf. Tab. B.1.39);
- the Min results coming from **1/3 OCTAVE** analysis (cf. Tab. B.1.40).

Below, all file structure groups are described separately in Tab. B.1.1 ÷ Tab. B.1.40. The format used in the columns, named **Comment** with the square parenthesis (**[xx**, **yy]**), means the contents of

the word with **xx** is the most significant byte (MSB) and **yy** the least significant byte (LSB) of the word. The format **0xnnnn** means that the **nnnn** is four-digit number in hexadecimal form.

Table B.1.1. FILE HEADER

Word number	Name / Value	Comment
0	0xnn01	[01, nn=header_length]
1..4	FileName	file or buffer name (8 characters) if the name starts with two '@' characters, following 6 bytes contain measurement date and time coded as BCD (each saved digit is increased by one)
5	FileType	0x0000 - file containing results from buffer's file 0x01nn - file containing measurements results 0x0200 - file containing instrument's setup data
6	CurrentDate	file creation date
7	CurrentTime	file creation time
8..11	AssBufFileName	name of the associated buffer or file (8 bytes)

Table B.1.2. UNIT AND SOFTWARE SPECIFICATION

Word number	Name / Value	Comment
0	0xnn02	[02, nn=specification_length]
1	UnitNumber	unit number
2	UnitType	unit type: 958
3	SoftwareVersion	software version * 100
4	SoftwareIssueDate	software issue date
5	UnitSubtype	unit subtype: 1
6	FilesystemVersion	filesystem version * 100
7	LevelMeterVersion	meter software version * 100

Table B.1.3. PARAMETERS AND GLOBAL SETTINGS

Word number	Name / Value	Comment
0	0xnn04	[04, nn=block_length]
1	CycleStartDate	measurement cycle start date
2	CycleStartTime	measurement cycle start time
3	DeviceFunction	1 - **LEVEL METER**, 2 - **1/1 OCTAVE** analyser, 3 - **1/3 OCTAVE** analyser, 4 - sound **DOSEMETER**, 6 - **FFT** analyser
4	UnitFlags	flags word (16 bits): b15 ... b3 b2 b1 b0 b0 - if set to 1: calibration coefficient is used b1 - if set to 1: overload occurred b2 - if set to 1: "Human vibrations" excluded (0 - means "Human vibrations" included and then **VDV** result is present) b5,b4,b3: type of the result Result[p][7] (p = 1,2,3,4) 000 - **Lden** result is not available 001 - **Ld** result 010 - **Le** result 011 - **Lde** result 100 - **Ln** result 101 - **Lnd** result 110 - **Len** result 111 - **Lden** result b6 - if set to 1: overload occurred in the 4th channel b7 - if set to 1: overload occurred in the 3rd channel b8 - if set to 1: overload occurred in the 2nd channel b9 - if set to 1: overload occurred in the 1st channel b10, ..., b15 - reserved

5	RepCycle	0 - infinity nnnn - number of repetitions $\in (1 \div 1000)$
6	StartDelay	start delay time specified in milliseconds $\in (1 \div 60000)$
7..8	IntTimeSec	0 - infinity integration time specified in seconds
9	TriggerChannel	source channel of the triggering signal: 0 (the 1st channel) .. 3 (the 4th channel)
10	TriggerMode	trigger mode: 0 - **OFF**, 1 - **SLOPE +**, 2 - **SLOPE -**, 3 - **LEVEL +**, 4 - **LEVEL -**, 5 - **BUFFER**, 6 - **GRADIENT +**, 7 - **RTC**
11	TriggerSource	source of the triggering signal: 0 - the **VEC** result 1 - the **VEC** result and **RMS(1)** result from selected channel 2 - the **RMS(1)** result from the selected channel 3 - the External trigger in the case of **1/1 OCTAVE** analyser: nn - number of **1/1 OCTAVE** filter $\in (8 \div NOct)$ in the case of **1/3 OCTAVE** analyser nn - number of **TOTAL LIN** result (48)
12	TriggerLev	level of triggering: 24..136 dB in the case of source channel set in Sound Meter mode, 60..200 dB in the case of source channel in Vibration Meter mode
13	VecTriggerLev	level of triggering for **VEC** result: 60..200 dB
14	TriggerPre	number of the records taken into account before the fulfilment of the triggering condition $\in (1 \div 20)$
15	TriggerPost	number of the records taken into account after the fulfilment of the triggering condition $\in (1 \div 200)$
16	LeqInt	detector's type in the **LEQ** function: 0 - **LINEAR**, 1 - **EXPONENT.**
17	Reserved	reserved
18	RefLev_a	reference level for acceleration given in $\mu ms^{-2} \in (1 \div 100)$
19	RefLev_v	reference level for velocity given in $nms^{-1} \in (1 \div 100)$
20	RefLev_d	reference level for displacement given in pm $\in (1 \div 100)$
21	NofChannels	number of channels (4)
22	NofProfiles	number of profiles (12)
23	NotSpect	number of spectrum (4)
24	LowesTerFreq	the lowest possible 1/3 octave frequency (*100Hz)
25	CalibrType	calibration type: 0 - calibration not performed 1 - calibration by measurement 2 - calibration by sensitivity
26	CalibrDate	date of the last calibration
27	CalibrTime	time of the last calibration
28	TriggerGrad	the gradient level for gradiend trigger mode
29	DoseExposureTime	exposure time for dosemeter function (min.)
30	DoseCriterionLev	Criterion level (*100dB)
31	DoseTresholdLev	Threshold level (*100dB)
32	DoseExchangeRate	Exchange Rate (dB)
33	RPM_On	RPM measurement: 0 - switched off; 1 - switched on
34	RPM_Pulse	Pulses per rotation $\in (1 \div 360)$
35	RPM_Buffer	RPM results buffering: 0 - switched off; 1 - switched on
36	CycleMeasurementStartDate	measure start date
37..38	CycleMeasurementStartTime	measure start time

Table B.1.4. HARDWARE SETTINGS FOR CHANNELS

Word number	Name / Value	Comment
0	0xnn05	[05, nn=block_length]

1	0x0706	[06, 07=subblock_length]
2	ChannelMode[1]	mode of the 1st channel 0 - Vibration Level Meter / Analyser 1 - Sound Level Meter / Analyser
3	CalibrFactor[1]	calibration factor (*10 dB) in the 1st channel
4	Range[1]	range in the 1st channel 1 - **105 dB,** 2 - **130 dB** in the case of **SLM** 1 - **17.8 ms^{-2}**, 2 - **316 ms^{-2}** in the case of **VLM**
5	Reserved	reserved
6	MicFieldCorr[1]	field correction: 0 - **FREE**, 1 - **DIFFUSE** in the case of **SLM**
7	MicOutdoor[1]	outdoor microphone kit correction: 1 - enabled in the case of **SLM**
8	0x0706	[06, 07=subblock_length]
9	ChannelMode[2]	mode of the 2nd channel: 0 - Vibration Level Meter / Analyser 1 - Sound Level Meter / Analyser
10	CalibrFactor[2]	calibration factor (*10 dB) in the 2nd channel
11	Range[2]	range in the 2nd channel: 1 - **105 dB,** 2 - **130 dB** in the case of **SLM** 1 - **17.8 ms^{-2}**, 2 - **316 ms^{-2}** in the case of **VLM**
12	Reserved	reserved
13	MicFieldCorr[2]	field correction: 0 - **FREE**, 1 - **DIFFUSE** in the case of **SLM**
14	MicOutdoor[2]	outdoor microphone kit correction: 1 - enabled in the case of **SLM**
15	0x0706	[06, 07=subblock_length]
16	ChannelMode[3]	mode of the 3rd channel: 0 - Vibration Level Meter / Analyser 1 - Sound Level Meter / Analyser
17	CalibrFactor[3]	calibration factor (*10 dB) in the 3rd channel
18	Range[3]	range in the 3rd channel: 1 - **105 dB,** 2 - **130 dB** in the case of **SLM** 1 - **17.8 ms^{-2}**, 2 - **316 ms^{-2}** in the case of **VLM**
19	Reserved	reserved
20	MicFieldCorr[3]	field correction: 0 - **FREE**, 1 - **DIFFUSE** in the case of **SLM**
21	MicOutdoor[3]	outdoor microphone kit correction: 1 - enabled in the case of **SLM**
22	0x0706	[06, 07=subblock_length]
23	ChannelMode[4]	mode of the 4th channel: 0 - Vibration Level Meter / Analyser 1 - Sound Level Meter / Analyser
24	CalibrFactor[4]	calibration factor (*10 dB) in the 4th channel
25	Range[4]	range in the 4th channel: 1 - **105 dB,** 2 - **130 dB** in the case of **SLM** 1 - **17.8 ms^{-2}**, 2 - **316 ms^{-2}** in the case of **VLM**
26	Reserved	reserved
27	MicFieldCorr[4]	field correction: 0 - **FREE**, 1 - **DIFFUSE** in the case of **SLM**
28	MicOutdoor[4]	outdoor microphone kit correction: 1 - enabled in the case of **SLM**

Table B.1.5. SOFTWARE SETTINGS FOR CHANNELS

Word number	Name / Value	Comment
0	0xnn07	[07, nn=block_length]
1	0x040C	[used_channel, used profile]
2..7	ProfileSett[1]	first profile settings for the 1st channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode (see below)

8..13	ProfileSett[2]	first profile settings for the 2nd channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
14..19	ProfileSett[3]	first profile settings for the 3rd channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
20..25	ProfileSett[4]	first profile settings for the 4th channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
26..31	ProfileSett[5]	second profile settings for the 1st channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode (see below)
32..37	ProfileSett[6]	second profile settings for the 2nd channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
38..43	ProfileSett[7]	second profile settings for the 3rd channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
44..49	ProfileSett[8]	second profile settings for the 4th channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
50..55	ProfileSett[9]	third profile settings for the 1st channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode (see below)
56..61	ProfileSett[10]	third profile settings for the 2nd channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
62..67	ProfileSett[11]	third profile settings for the 3rd channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode
68..73	ProfileSett[12]	third profile settings for the 4th channel, defined in Table **B.1.5_SLM** in the case of **SLM** mode or in Table **B.1.5_VLM** in the case of **VLM** mode

Table B.1.5_SLM. SOFTWARE SETTINGS FOR A CHANNEL IN THE CASE OF SLM MODE

Word number	Name / Value	Comment
0	0xnn08	[08, nn=block_length]
1	ChannelNo	number of channel: 0 - first channel
2	FilterP	filter type in the channel: 1 - **LIN**, 2 - **A**, 3 - **C**, 4 – **G**
3	DetectorP	detector type in the channel: 0 - **IMP.**, 1 - **FAST**, 2 – **SLOW**
4	BufferP	buffer contents in the channel defined as a sum of : 1 - for **PEAK** results, 2 - for **MAX** results, 4 - for **MIN** results, 8 - for **RMS** results,
5	ProfileFlags	flags word (16 bits): b15 ... b3 b2 b1 b0 b0 - if set to 1: profile results have been calculated b1 ... b15 – reserved

Table B.1.5_VLM. SOFTWARE SETTINGS FOR A CHANNEL IN THE CASE OF VLM MODE

Word number	Name / Value	Comment
0	0xnn08	[08, nn=subblock_length]
1	ChannelNo	channel number: 0 - the 1st channel
2	FilterP	filter type in the channel: 1 - **HP1**, 2 - **HP3**, 3 - **HP10**, 4 - **Vel1**, 5 - **Vel3**, 6 - **Vel10**, 7 - **VelMF**, 8 - **Dil1**, 9 - **Dil3**, 10 - **Dil10**, 15 - **KB**, 16 - **Wk**, 17 - **Wd**, 18 - **Wc**, 19 - **Wj**, 20 - **Wm**, 21 - **Wh**, 22 - **Wg**, 23 - **Wb**
3	DetectorP	detector type in the channel: 0 - **100 ms**, 1 - **125 ms**, 2 - **200 ms**, 3 - **500 ms**, 4 - **1 s**, 5 - **2 s**, 6 - **5 s**, 7 - **10 s**
4	BufferP	buffer contents in the channel defined as a sum of: 1 - for **PEAK** results, 2 - for **P–P** results, 4 - for **MAX** results, 8 - for **RMS** results, 16 - for **VDV** results
5	ProfileFlags	flags word (16 bits): b15 ... b3 b2 b1 b0 b0 - if set to 1: profile results have been calculated b1 ... b15 – reserved

Table B.1.6. VECTOR MEASUREMENT SETTINGS

Word number	Name / Value	Comment
0	0xnn1E	[1E, nn=subblock_length]
1	VectorBufferP	vector result buffering: 0 - **OFF**, 1 - **ON**
2	VectorCoeff[1]	vector coefficient for the RMS value from the 1st channel (*100)
3	VectorCoeff[2]	vector coefficient for the RMS value from the 2nd channel (*100)
4	VectorCoeff[3]	vector coefficient for the RMS value from the 3rd channel (*100)
5	VectorCoeff[4]	vector coefficient for the RMS value from the 4th channel (*100)
6	VectorOn[1]	RMS value from the 1st channel used for calculation: 0 - no, 1 - yes
7	VectorOn[2]	RMS value from the 2nd channel used for calculation: 0 - no, 1 - yes
8	VectorOn[3]	RMS value from the 3rd channel used for calculation: 0 - no, 1 - yes
9	VectorOn[4]	RMS value from the 4th channel used for calculation: 0 - no, 1 - yes
10	VectorResult	**VECTOR** result value (*100 dB)

Table B.1.7. OCTAVES ANALYSIS HEADER

Word number	Name / Value	Comment
0	0xnn09	[09, nn=block_length]
1	0xkknn	[nn=spectrum_mask, kk=used_spectrum]
2..5	OctaveHead[1]	header of the first enabled octave analysis, defined in Table **B.1.7_SLM** in the case of **SLM** mode or in Table **B.1.7_VLM** in the case of **VLM** mode (see below)
…	…	…
2+4*used_spectrum..5+4*used_spectrum	OctaveHead[used_spectrum]	header of the last enabled octave analysis, defined in Table **B.1.7_SLM** in the case of **SLM** mode or in Table **B.1.7_VLM** in the case of **VLM** mode

Table B.1.7_SLM. OCTAVE ANALYSIS HEADER IN THE CASE OF SLM MODE

Word number	Name / Value	Comment
0	0xnn0A	[0A, nn=subblock length]
1	SpectrumChannel	spectrum channel
2	SpectrumFilter	**1/1** or **1/3 OCTAVE** analysis filter: 0 - **HP**, 1 - **LIN**, 2 - **A**, 3 - **C**
3	SpectrumBuff	**1/1** or **1/3 OCTAVE** buffering: 1 - **ON**, 0 - **OFF**

Table B.1.7_VLM. OCTAVE ANALYSIS HEADER IN THE CASE OF VLM MODE

Word number	Name / Value	Comment
0	0xnn0A	[0A, nn=subblock length]
1	SpectrumChannel	spectrum channel
2	SpectrumFilter	**1/1** or **1/3 OCTAVE** analysis filter: 0 - **HP**
3	SpectrumBuff	**1/1** or **1/3 OCTAVE** buffering: 1 - **ON**, 0 - **OFF**

Table B.1.8. HEADER OF THE FFT ANALYSIS

Word number	Name / Value	Comment
0	0xnn0B	[0B, nn=block_length] nn=2+NumberOfEnabledFFTs*12
1	0xkkmm	[mm=spectrum_mask,kk=spectrum_count]
2..13	FFTHeader[1]	header of the first enabled **FFT** analysis, defined in Table **B.1.8_SLM** in the case of **SLM** mode or in Table **B.1.8_VLM** in the case of **VLM** mode (see below)
…	…	
2+spectrum_count*12..13+spectrum_count*12	FFTHeader[spectrum_count]	header of the last enabled **FFT** analysis, defined in Table **B.1.8_SLM** in the case of **SLM** mode or in Table **B.1.8_VLM** in the case of **VLM** mode

Table B.1.8_SLM. HEADER OF THE FFT ANALYSIS IN ONE CHANNEL SLM MODE

Word number	Name / Value	Comment
0	0xnn0C	[0C, nn=block_length]
1	FFTChannel	channel of **FFT** analysis
2	FFTFilter	**FFT** analysis filter: 0 - **HP**, 1 - **LIN**, 2 - **A**, 3 - **C**
3	FFTBuff	**FFT** buffering: 1 - **ON**, 0 - **OFF**
4	LowestFreqNo	number of the first line in the **FFT** spectrum = 0
5	NFft	number of lines in the spectrum = 1921, 961 or 481
6	NFftTot	number of TOTAL lines in the spectrum = 1
7	FftBand	band of the **FFT** analysis: 1 – **22.4 kHz**, 2 – **11.2 kHz**, 3 – **5.6 kHz**, 4 - **2.8 kHz**, 5 - **1.4 kHz**, 6 - **700 Hz**, 7 - **350 Hz**, 8 - **175 Hz**, 9 – **87.5 Hz**
8	FftWindow	window in the **FFT** analysis: 0 - **HANNING**,1 - **RECTANGLE**, 2 - **FLAT TOP**, 3 - **KAISER-BESSEL**
9	FftAverag	type of averaging in the **FFT** analysis: 0 - **LINEAR**
10..11	FftSampFreq	sampling frequency
12	FftWFactor	Window coefficient
13	FftLines	number of lines: 0 - 1920 lines, 1 - 960 lines, 2 - 480 lines

Table B.1.8_VLM. HEADER OF THE FFT ANALYSIS IN ONE CHANNEL VLM MODE

Word number	Name / Value	Comment
0	0xnn0C	[0C, nn=block_length]
1	FFTChannel	channel of **FFT** analysis
2	FFTFilter	**FFT** analysis filter: 0 - **HP**
3	FFTBuff	**FFT** buffering: 1 - **ON**, 0 - **OFF**
4	LowestFreqNo	number of the first line in the **FFT** spectrum = 0
5	NFft	number of lines in the spectrum = 1921, 961 or 481

6	NFftTot	number of TOTAL lines in the spectrum = 1
7	FftBand	band of the FFT analysis: 1 – **22.4 kHz**, 2 – **11.2 kHz**, 3 – **5.6 kHz**, 4 - **2.8 kHz**, 5 - **1.4 kHz**, 6 - **700 Hz**, 7 - **350 Hz**, 8 - **175 Hz**, 9 – **87.5 Hz**
8	FftWindow	window in the **FFT** analysis: 0 - **HANNING,1 - RECTANGLE**, 2 - **FLAT TOP**, 3 - **KAISER-BESSEL**
9	FftAverag	type of averaging in the **FFT** analysis: 0 - **LINEAR**
10..11	FftSampFreq	sampling frequency
12	FftWFactor	Window coefficient
13	FftLines	number of lines: 0 - 1920 lines, 1 - 960 lines, 2 - 480 lines

Table B.1.9. SETTINGS FOR VIBRATION DOSE MEASUREMENT

Word number	Name / Value	Comment
0	0xnn1F	[1F, nn=block_length]
1	xxyy	[yy=channel of Y axis-1 ,xx=channel of X axis-1]
2	nnzz	[zz=channel of Z axis-1, nn] nn=1 for Hand-Arm measurement, nn=2 for Whole-Body measurement
3	ExposureTime	exposure time in minutes
4	Standard	standard: 0 - **UK**, 1 - **Italy**, 2 - **Poland**, 3 - **French**, 4 - **User**

Table B.1.10. MAIN RESULTS

Word number	Name / Value	Comment
0	0xnn0D	[0D, nn=subblock_length]
1	0x040C	[used_channel, used profiles]
2..15	MainResults[1]	main results from first profile of the 1st channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode (see below)
16..29	MainResults[2]	main results from first profile of the 2nd channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
30..43	MainResults[3]	main results from first profile of the 3rd channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
44..57	MainResults[4]	main results from first profile of the 4th channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
58..71	MainResults[5]	main results from second profile of the 1st channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode (see below)
72..85	MainResults[6]	main results from second profile of the 2nd channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
86..99	MainResults[7]	main results from second profile of the 3rd channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
100..113	MainResults[8]	main results from second profile of the 4th channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
114..127	MainResults[9]	main results from third profile of the 1st channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode (see below)
128..141	MainResults[10]	main results from third profile of the 2nd channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode

142..155	MainResults[11]	main results from third profile of the 3rd channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode
156..169	MainResults[12]	main results from third profile of the 4th channel, defined in Table **B.1.10_SLM** in the case of **SLM** mode or in Table **B.1.10_VLM** in the case of **VLM** mode

Table B.1.10_SLM. ONE PROFILE MAIN RESULTS IN THE CASE OF SLM MODE

Word number	Name / Value	Comment
0	0xnn0E	[0E, nn=subblock_length]
1..2	MeasureTime	time of the measurement in the channel (if the 1st profile in channel) overload time in the channel (if second profile in channel)
3	Result[1]	**PEAK** value in the profile (*100 dB)
4	Result[2]	reserved
5	Result[3]	minimal value (**MIN**) in the profile (*100 dB)
6	Result[4]	**SPL** value in the profile (*100 dB)
7	Result[5]	maximal value (**MAX**) in the profile (*100 dB)
8	Result[6]	**Lden** value in the profile (*100 dB) (depends on UnitFlags bits: b3, b4, b5)
9	Result[7]	**LEQ** value in the profile (*100 dB)
10	Result[8]	**Ltm3** value in the profile (*100 dB)
11	Result[9]	**Ltm5** value in the profile (*100 dB)
12	Result[10]	**Lav** value in the profile (*100dB), (the result enable only dosemeter function)
13	Result[11]	**TLav** value in the profile (*100dB), (the result enable only dosemeter function)

Table B.1.10_VLM. ONE PROFILE MAIN RESULTS IN THE CASE OF VLM MODE

Word number	Name / Value	Comment
0	0xnn0E	[0E, nn=subblock_length]
1..2	MeasureTime	time of the measurement in the channel(if the 1st profile in channel) overload time in the channel (if second profile in channel)
3	Result[1]	**PEAK** value in the profile (*100 dB)
	Result[2]	**P–P** value in the profile (*100 dB)
5	Result[3]	reserved
6	Result[4]	reserved
7	Result[5]	**MTVV** (or **MAX**) value in the profile (*100 dB)
8	Result[6]	**VDV** value in the profile (if UnitFlags bit b2 is set to 0) (*100 dB)
9	Result[7]	**RMS** value in the profile (*100 dB)
10	Result[8]	reserved
11	Result[9]	reserved
12	Result[10]	reserved
13	Result[11]	reserved

Table B.1.11. SELECTED STATISTICAL LEVELS IN CHANNELS

Word number	Name / Value	Comment
0	0xnn19	[19, nn=block_length]
1	0xccmm	[mm=channel_mask,cc= used_channels]
2	NStatLevs	number of statistical levels per channel = 10
3	N1	N1 value for the LN1 statistics $\in (1 \div 99)$
4	N2	N2 value for the LN2 statistics $\in (1 \div 99)$

5	N3	N3 value for the LN3 statistics ∈ (1 ÷ 99)
6	N4	N4 value for the LN4 statistics ∈ (1 ÷ 99)
7	N5	N5 value for the LN5 statistics ∈ (1 ÷ 99)
8	N6	N6 value for the LN6 statistics ∈ (1 ÷ 99)
9	N7	N7 value for the LN7 statistics ∈ (1 ÷ 99)
10	N8	N8 value for the LN8 statistics ∈ (1 ÷ 99)
11	N9	N9 value for the LN9 statistics ∈ (1 ÷ 99)
12	N10	N10 value for the LN10 statistics ∈ (1 ÷ 99)
13	LN1[1]	value of the LN1 statistics (*10 dB) for the 1st channel in **SLM** mode
14	LN2[1]	value of the LN2 statistics (*10 dB) for the 1st channel in **SLM** mode
…	…	…
22	LN10[1]	value of the LN10 statistics (*10 dB) for the 1st channel in **SLM** mode
23	LN1[2]	value of the LN1 statistics (*10 dB) for the 2nd channel in **SLM** mode
...	...	...
block_length-1	LN10[used_channels]	value of the LN10 statistics (*10 dB) for the last channel in **SLM** mode

Table B.1.12. ONE CHANNEL 1/1 OCTAVE ANALYSIS RESULTS

Word number	Name / Value	Comment
0	0xnn0F	[0F, nn=block_length]
1	LowestFreq	the lowest **1/1 OCTAVE** frequency (*100 Hz)
2	Noct	number of **1/1 OCTAVE** values
3	NoctTot	number of **TOTAL** values = 3
4… block_length	Octave[i]	1/1 octave[i] value (*100 dB); i=1..NOct+NOctTot

Note: *The **TOTAL** values, calculated in the case of sound measurements, correspond to the **A**, **C** and **LIN** filters – respectively. The **TOTAL** values, calculated in the case of vibration measurements, correspond to the **HP**, **CH** and **CH** filters – respectively, where **CH** denotes the filter used in the channel for Level Meter measurement.*

Table B.1.13. ONE CHANNEL 1/3 OCTAVE ANALYSIS RESULTS

Word number	Name / Value	Comment
0	0xnn10	[10, nn=block_length]
1	LowestFreq	the lowest **1/3 OCTAVE** frequency (*100 Hz)
2	Nter	number of **1/3 OCTAVE** values
3	NterTot	number of **TOTAL** values = 3
4... block_length	Tercje[I]	1/3 octave[i] value (*100 dB); i=1..NTer+NTerTot

Note: *The **TOTAL** values, calculated in the case of sound measurements, correspond to the **A**, **C** and **LIN** filters – respectively. The **TOTAL** values, calculated in the case of vibration measurements, correspond to the **HP**, **CH** and **CH** filters – respectively, where **CH** denotes the filter used in the channel for Level Meter measurement.*

Table B.1.14. ONE CHANNEL FFT ANALYSIS RESULTS

Word number	Name / Value	Comment
0	0x0011	[11, 0 (block is longer than 256 words, the length is given in the second word)]
1	FftBlockLength	2 + NFft + NFftTot
2..2+NFft + NFftTot	FFT[i]	value of the FFT line (*100 dB); i = 1..1..NFft + NFftTot

Table B.1.15. ONE CHANNEL TOTALS DESCRIPTION

Word number	Name / Value	Comment
0	0xnn1B	[1B, nn=block_length = 1 + Ntotal*4 (words)]
1	SpectChannel	spectrum channel
2	FilterNo[1]	logical filter no. for the first total value 0, 1, 2 - standard filters 3,… - user defined filters
3	FilterType[1]	for sound: 0 for vibration: 0 - **ACC**., 1 - **VEL**., 2 - **DIL**.
4	calFactor[1]	calibration factor used to modify the computed **TOTAL** value
5	TotValue[1]	**TOTAL** value computed for the filter with logical no. FilterNo or zero value for standard filter
…	…	…
nn-4	FilterNo[Ntotal]	logical filter no. for the last total value 0, 1, 2 - standard filters 3,… - user defined filters
nn-3	FilterType[Ntotal]	for sound: 0 for vibration: 0 - **ACC**., 1 - **VEL**., 2 - **DIL**.
nn-2	calFactor[Ntotal]	calibration factor used to modify the computed **TOTAL** value
nn-1	TotValue[Ntotal]	**TOTAL** value computed for the filter with logical no. FilterNo or zero value for standard filter

Table B.1.16. TOTALS DESCRIPTION

Word number	Name / Value	Comment
0	0xnn1A	[1A, nn=block_length = 1+(1 + Ntotal*4)*k (words)]
1... 1+4*Ntotal	OneChnlTotDesc[1]	One channel totals description block for the first channel with **USER FILTER TOTALS** (Table **B.1.15.**)
…	…	…
	OneChnlTotDesc[k]	One channel totals description block for the last channel with **USER FILTER TOTALS** (Table **B.1.15.**)

Note: *This data block is created only in the case when the file was saved for **1/1 OCTAVE** or **1/3 OCTAVE** analysis and the **TOTAL** values were calculated for the filters selected by the user (**USER FILTERS**). The **TOTAL** values corresponding to those filters are given in the TotValue positions and the definitions of the proper filters are presented in the Table B.1.17.*

Table B.1.17. USER DEFINED FILTER DESCRIPTION

Word number	Name / Value	Comment
0	0xnn1D	[1D, nn=block_length = 5 + NTer (words)]
1	FilterNo	FilerNo as saved in ONE CHANNEL TOTALS DESCRIPTION Table (B.1.15)
2..4	FilterName	filter name (up to 5 letters, zero-ending string)
5..49	FilterVal[i]	filter value (*10 dB) corresponding to the 1/3 octave[i] position; i=1..NTer (1..45)

Note: *Such data block is created for each filter with the logical number FilterNo greater or equal to 3, expressed in the TOTALS DESCRIPTION block (cf. Tab. B.1.15 and Tab B.1.16). The description of the filter with the logical number FilterNo is given only once, disregarding the number of FilterNo repetition in Tab. B.1.15.*

Table B.1.18. STATISTICS IN CHANNELS HEADER

Word number	Name / Value	Comment
0	0xnn12	[12, nn=block_length=2+4*used_channels]
1	0xccmm	[mm=channels_mask, cc=used_channels]
2	0x0413	[13, 04=subblock_length]
3	NofClasses[1]	number of classes in the 1st channel in **SLM** mode (100)
4	BottomClass[1]	bottom class boundary (*10 dB) in the 1st channel in **SLM** mode
5	ClassWidth[1]	class width (*10 dB) in the 1st channel in **SLM** mode
…	…	…
block_ length-4	0x0413	[13, 04=subblock_length]
block_ length-3	NofClasses[used_ channels]	number of classes in the last channel in **SLM** mode (100)
block_ length-2	BottomClass[used_ channels]	bottom class boundary (*10 dB) in the last channel in **SLM** mode
block_ length-1	ClassWidth[used_ channels]	class width (*10 dB) in the last channel in **SLM** mode

Table B.1.19. RESULTS OF THE STATISTICAL ANALYSIS IN ONE CHANNEL

Word number	Name / Value	Comment
0	0x0014	[14, 00=block length in next word]
1	SubblockLength	2 * number of classes in the channel + 3
2	ChannelNo	channel number minus 1
3..4	Histogram[1]	the 1st counter in the channel
5..6	Histogram[2]	the 2nd counter in the channel
.....	.....	.....

Table B.1.20. RESULTS OF THE STATISTICAL ANALYSIS PERFORMED IN 1/1 OCTAVE OR 1/3 OCTAVE MODE

Word number	Name / Value	Comment
0	0x0015	[15, 00=block length in the next word]
1	BlockLength	Block length
2	0xccmm	[mm=spectrum_mask, cc=used_spectrum]
3..	OctStatRes[1]	results of the statistical analysis performed in the 1st channel in **SLM** mode (defined in Table **B.1.21.**)
....	….	....
	OctStatRes[used_ spectrum]	results of the statistical analysis performed in the last channel in **SLM** mode (defined in Table **B.1.21.**)

Table B.1.21. RESULTS OF THE STATISTICAL ANALYSIS PERFORMED IN 1/1 OCTAVE OR 1/3 OCTAVE MODE IN ONE CHANNEL

Word number	Name / Value	Comment
0	0x0016	[16, 00=block length in next word]
1	BlockLength	BlockLength=2*NofHist*NofClass+6
2	NofHist	number of histogramms (number of **1/1 OCTAVE** or **1/3 OCTAVE** filters and **TOTAL** values (3))
3	NofClasses	number of classes in the histogramm (100)
4	BottomClass	bottom class boundary (*10 dB)
5	ClassWidth	class width (*10 dB)
6..7	Histogram[1][1]	the 1st counter for the first **1/1 OCTAVE** or **1/3 OCTAVE** filter
8..9	Histogram[1][2]	the 2nd counter for the first **1/1 OCTAVE** or **1/3 OCTAVE** filter
.....	.....	.....
6+2 * Nof Classes… 7+2 * Nof Classes	Histogram[2][1]	the 1st counter for the second **1/1 OCTAVE** or **1/3 OCTAVE** filter
...	Histogram[2][2]	the 2nd counter for the second **1/1 OCTAVE** or **1/3 OCTAVE** filter
.....	.....	.....
.....	.....	.....
...	Histogram[NofHist][1]	the 1st counter for the last **1/1 OCTAVE** or **1/3 OCTAVE** filter
…	Histogram[NofHist][2]	the 2nd counter for the last **1/1 OCTAVE** or **1/3 OCTAVE** filter
.....	.....	.....

Table B.1.22. HEADER OF THE FILE FROM THE BUFFER

Word number	Name / Value	Comment
0	0xnn18	[18, nn=header_length]
1	BufResOffs	position of the first saved result
2	BuffTSec	buffer time step - full seconds part
3	BuffTMilisec	buffer time step - milliseconds part
4..5	BuffLength	buffer length (bytes)
6..7	RecsInBuff	number of records in the buffer
8..9	RecsInObserv	number of records in the observation period equal to: number of records in the buffer + number of records not saved

Note: *The current buffer time step in seconds can be obtained from the formulae:*
T = BuffTSec + BuffTMilisec / 1000.

Table B.1.23. SPECTRUM HEADER OF THE FILE FROM THE BUFFER

Word number	Name / Value	Comment
0	0xnn21	[21, nn=block_length=1+4*NumberOfBufferedSpectrums]
1	ChannelNo	channel number of the first buffered spectrum minus 1
2	LowestFreq	the lowest **1/1 OCTAVE** or **1/3 OCTAVE** frequency (*100 Hz) of the first buffered spectrum or 0 in the case of **FFT**
3	NSpectRes	number of **1/1 OCTAVE** or **1/3 OCTAVE** or **FFT** results of the first buffered spectrum
4	NTotal	number of **TOTAL** values of the first buffered spectrum
…	…	…

block_ length-4	ChannelNo	channel number of the last buffered spectrum minus 1
block_ length-3	LowestFreq	the lowest **1/1 OCTAVE** or **1/3 OCTAVE** frequency (*100 Hz) of the last buffered spectrum or 0 in the case of **FFT**
block_ length-2	NSpectRes	number of **1/1 OCTAVE** or **1/3 OCTAVE** or **FFT** results of the last buffered spectrum
block_ length-1	NTotal	number of **TOTAL** values of the last buffered spectrum

Table B.1.24. CONTENTS OF THE FILE FROM THE BUFFER

Word number	Name / Value	Comment
0..(BuffLength/2-1)		result#1, result#2, ... result#(BuffLength/2-1)

Table B.1.25. FILE END MARKER

Word number	Name / Value	Comment
0	0xFFFF	file end marker

Table B.1.26. INSTRUMENT'S SETUP DATA BLOCK

Word number	Name / Value	Comment
0	0x0020	[20, 00=block lenght in the next word]
1	BlockLength	Block length
2..BlockLe ngth-1	SetupData	saved setup values

Table B.1.27. USER FILTERS BLOCK IN INSTRUMENT'S SETUP DATA FILE

Word number	Name / Value	Comment
0	0x0027	[27, 00=block length in the next word]
1	BlockLength	block length
2..BlockLe ngth-1	FilterData	saved user filters values

Table B.1.34. THE RESULTS OF ROTATION SPEED MEASUREMENT

Word number	Name / Value	Comment
0	0xnn2A	[2A, nn=block length]
1	rpm[0]	RPM[0]
2	rpm[1]	RPM[1]
3	rpm_max[0]	RPM MAX[0]
4	rpm_max[1]	RPM MAX[1]
5	rpm_min[0]	RPM MIN[0]
6	rpm_min[1]	RPM MIN[1]

Table B.1.36. SEAT MEASUREMENT

Word number	Name / Value	Comment
0	0xnn2C	[2C, nn=block length]
1	SEATBaseChannel	base channel
2	SEATSeatChannel	seating channel

Table B.1.37. MAXIMUM RESULTS OF THE 1/1 OCTAVE ANALYSIS IN ONE CHANNEL

Word number	Name / Value	Comment
0	0xnn2D	[2D, nn=block length]
1	LowestFreq	the lowest **1/1 OCTAVE** frequency (*100 Hz)
2	Noct	number of **1/1 OCTAVE** values
3	NoctTot	number of **TOTAL** values = 3
4 - length block	MaxOctave[i]	maximum result of the 1/1 octave analysis (*100 dB); i = 1…NOct + NOctTot
	…	

Table B.1.38. MINIMUM RESULTS OF THE 1/1 OCTAVE ANALYSIS IN ONE CHANNEL

Word number	Name / Value	Comment
0	0xnn2E	[2E, nn=block length]
1	LowestFreq	the lowest **1/1 OCTAVE** frequency (*100 Hz)
2	Noct	number of **1/1 OCTAVE** values
3	NoctTot	number of **TOTAL** values = 3
4 - length block	MinOctave[i]	minimum result of the 1/1 octave analysis (*100 dB); i = 1…NOct + NOctTot

Note: *The **TOTAL** values, calculated in the case of sound measurements, correspond to the **A**, **C** and **LIN** filters – respectively. The **TOTAL** values, calculated in the case of vibration measurements, correspond to the **HP**, **CH** and **CH** filters – respectively, where **CH** denotes the filter used in the channel for Level Meter measurement.*

Table B.1.39. MAXIMUM RESULTS OF THE 1/3 OCTAVE ANALYSIS IN ONE CHANNEL

Word number	Name / Value	Comment
0	0xnn2F	[2F, nn=block length]
1	LowestFreq	the lowest **1/3 OCTAVE** frequency (*100 Hz)
2	Nter	number of **1/3 OCTAVE** values
3	NterTot	number of **TOTAL** values = 3
4 – length block	MaxTercje[I]	maximum result of the 1/3 octave analysis (*100 dB); i = 1…NTer + NterTot

Table B.1.40. MINIMUM RESULTS OF THE 1/3 OCTAVE ANALYSIS IN ONE CHANNEL

Word number	Name / Value	Comment
0	0xnn30	[30, nn=block length]
1	LowestFreq	the lowest **1/3 OCTAVE** frequency (*100 Hz)
2	Nter	number of **1/3 OCTAVE** values
3	NterTot	number of **TOTAL** values = 3
4 - length block	MinTercje[I]	minimum result of the 1/3 octave analysis (*100 dB); i = 1…NTer + NterTot

Note: *The **TOTAL** values, calculated in the case of sound measurements, correspond to the **A**, **C** and **LIN** filters – respectively. The **TOTAL** values, calculated in the case of vibration measurements, correspond to the **HP**, **CH** and **CH** filters – respectively, where **CH** denotes the filter used in the channel for Level Meter measurement.*

B.2. STRUCTURE OF THE FILE WITH THE RESULTS FROM THE LM MODE

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.
PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.
HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.
SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.
VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.
SETTINGS FOR VIBRATION DOSE MEASUREMENT (the presence depends on the **MEASURE DOSE** position and channel filter settings) - cf. Tab. B.1.9.
MAIN RESULTS - cf. Tab. B.1.10.
RPM RESULTS (present if RPM measurement was enabled) – cf. Tab. B.1.34.
SELECTED STATISTICAL LEVELS IN CHANNELS (the presence depends on the **MODE** position in the channel settings) - cf. Tab. B.1.11.
HEADER OF THE STATISTICAL ANALYSIS IN CHANNELS (the presence depends on the **SAVE STAT.** position) - cf. Tab. B.1.18.
RESULTS OF THE STATISTICAL ANALYSIS IN ONE CHANNEL (the presence depends on the **SAVE STAT.** position and **MODE** position in the channel settings) - cf. Tab. B.1.19.
FILE END MARKER - cf. Tab. B.1.25.

B.3. STRUCTURE OF THE FILE WITH 1/1 OCTAVE ANALYSIS RESULTS

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.
PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.
HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.
SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.
VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.
OCTAVES ANALYSIS HEADER - cf. Tab.B.1.7.
SETTINGS FOR VIBRATION DOSE MEASUREMENT (the presence depends on the **MEASURE DOSE** position and channel filter settings) - cf. Tab. B.1.9.

MAIN RESULTS - cf. Tab. B.1.10.

RPM RESULTS (present if RPM measurement was enabled) – cf. Tab. B.1.34.

SELECTED STATISTICAL LEVELS IN CHANNELS (SLM mode channels only) - cf. Tab. B.1.11.

ONE CHANNEL 1/1 OCTAVES ANALYSIS RESULTS (one for each channel with spectrum analysis enabled) - cf. Tab. B.1.12.

TOTALS DESCRIPTION (if needed) - cf. Tab. B.1.16.

USER DEFINED FILTER DESCRIPTION (if needed) - cf. Tab. B.1.17.

ONE CHANNEL MAXIMUM 1/1 OCTAVES ANALYSIS RESULTS (one for each channel with spectrum analysis enabled, presence depends on the **MAX. SPECT.** position) - cf. Tab. B.1.37.

ONE CHANNEL MINIMUM 1/1 OCTAVES ANALYSIS RESULTS (one for each channel with spectrum analysis enabled, presence depends on the **MIN. SPECT.** position) - cf. Tab. B.1.38.

HEADER OF THE STATISTICAL ANALYSIS IN CHANNELS (the presence depends on the **SAVE STAT.** position) - cf. Tab. B.1.18.

RESULTS OF THE STATISTICAL ANALYSIS IN ONE CHANNEL (the presence depends on the **SAVE STAT.** position and **MODE** position in the channel settings) - cf. Tab. B.1.19.

RESULTS OF THE STATISTICAL ANALYSIS PERFORMED IN 1/1 OCTAVE MODE (SLM channels only - the presence depends on the **SAVE STAT.** position) - cf. Tab. B.1.20.

FILE END MARKER - cf. Tab. B.1.25.

B.4. STRUCTURE OF THE FILE WITH 1/3 OCTAVE ANALYSIS RESULTS

FILE HEADER - cf. Tab. B.1.1.

UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.

PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.

HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.

SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.

VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.

OCTAVES ANALYSIS HEADER - cf. Tab.B.1.7.

SETTINGS FOR VIBRATION DOSE MEASUREMENT (the presence depends on the **MEASURE DOSE** position and channel filter settings) - cf. Tab. B.1.9.

MAIN RESULTS - cf. Tab. B.1.10.

RPM RESULTS (present if RPM measurement was enabled) – cf. Tab. B.1.34.

SELECTED STATISTICAL LEVELS IN CHANNELS (SLM mode channels only) - cf. Tab. B.1.11.

ONE CHANNEL 1/3 OCTAVES ANALYSIS RESULTS (one for each channel with spectrum analysis enabled) - cf. Tab. B.1.13.

ONE CHANNEL MAXIMUM 1/3 OCTAVES ANALYSIS RESULTS (one for each channel with spectrum analysis enabled, presence depends on the **MAX. SPECT.** position) - cf. Tab. B.1.39.

ONE CHANNEL MINIMUM 1/3 OCTAVES ANALYSIS RESULTS (one for each channel with spectrum analysis enabled, presence depends on the **MIN. SPECT.** position) - cf. Tab. B.1.40.

TOTALS DESCRIPTION (if needed) - cf. Tab. B.1.16.

USER DEFINED FILTER DESCRIPTION (if needed) - cf. Tab. B.1.17.

HEADER OF THE STATISTICAL ANALYSIS IN CHANNELS (the presence depends on the **SAVE STAT.** position) - cf. Tab. B.1.18.

RESULTS OF THE STATISTICAL ANALYSIS IN ONE CHANNEL (the presence depends on the **SAVE STAT.** position and **MODE** position in the channel settings) - cf. Tab. B.1.19.

RESULTS OF THE STATISTICAL ANALYSIS PERFORMED IN 1/3 OCTAVE MODE (SLM channels only - the presence depends on the **SAVE STAT.** position) - cf. Tab. B.1.20.

FILE END MARKER - cf. Tab. B.1.25.

B.5. STRUCTURE OF THE FILE WITH THE FFT ANALYSIS RESULTS

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.
PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.
HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.
SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.
VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.
FFT ANALYSIS HEADER - cf. Tab.B.1.8.
SETTINGS FOR VIBRATION DOSE MEASUREMENT (the presence depends on the **MEASURE DOSE** position and channel filter settings) - cf. Tab. B.1.9.
MAIN RESULTS - cf. Tab. B.1.10.
RPM RESULTS (present if RPM measurement was enabled) – cf. Tab. B.1.34.
SELECTED STATISTICAL LEVELS IN CHANNELS (SLM mode channels only) - cf. Tab. B.1.11.
ONE CHANNEL FFT ANALYSIS RESULTS (one for each channel with spectrum analysis enabled) - cf. Tab.B.1.13.
HEADER OF THE STATISTICAL ANALYSIS IN CHANNELS (the presence depends on the **SAVE STAT.** position) - cf. Tab. B.1.18.
RESULTS OF THE STATISTICAL ANALYSIS IN ONE CHANNEL (the presence depends on the **SAVE STAT.** position and **MODE** position in the channel settings) - cf. Tab. B.1.19.
FILE END MARKER - cf. Tab. B.1.25.

B.6. STRUCTURE OF THE FILE CONTAINING LM RESULTS FROM BUFFER'S FILE

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.
PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.
HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.
SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.
VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.
HEADER OF THE FILE FROM THE BUFFER - cf. Tab.B.1.22.
CONTENTS OF THE FILE FROM THE BUFFER - cf. Tab.B.1.24.
FILE END MARKER - cf. Tab. B.1.25.

B.7. STRUCTURE OF THE FILE CONTAINING 1/1 OR 1/3 OCTAVE ANALYSIS RESULTS FROM BUFFER'S FILE

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.
PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.
HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.
SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.
VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.
HEADER OF THE FILE FROM THE BUFFER - cf. Tab.B.1.22.
OCTAVES ANALYSIS HEADER - cf. Tab.B.1.7.
SPECTRUM ANALYSIS HEADER OF THE FILE FROM THE BUFFER - cf. Tab.B.1.23.
CONTENTS OF THE FILE FROM THE BUFFER - cf. Tab.B.1.24.
FILE END MARKER - cf. Tab. B.1.25.

B.8. STRUCTURE OF THE FILE CONTAINING FFT ANALYSIS RESULTS FROM BUFFER'S FILE

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.

PARAMETERS AND GLOBAL SETTINGS - cf. Tab. B.1.3.
HARDWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.4.
SOFTWARE SETTINGS FOR CHANNELS - cf. Tab. B.1.5.
VECTOR MEASUREMENT SETTINGS - cf. Tab. B.1.6.
HEADER OF THE FILE FROM THE BUFFER - cf. Tab.B.1.22.
FFT ANALYSIS HEADER - cf. Tab.B.1.8.
SPECTRUM ANALYSIS HEADER OF THE FILE FROM THE BUFFER - cf. Tab.B.1.23.
CONTENTS OF THE FILE FROM THE BUFFER - cf. Tab.B.1.24.
FILE END MARKER - cf. Tab. B.1.25.

B.9. STRUCTURE OF THE FILE CONTAINING SAVED INSTRUMENT SETUP

FILE HEADER - cf. Tab. B.1.1.
UNIT AND SOFTWARE SPECIFICATION - cf. Tab. B.1.2.
INSTRUMENT's SETUP DATA BLOCK - cf. Tab.B.1.26.
USER FILTERS (the presence depends on the **SAVE FILT.** position) - cf. Tab.B.1.28.
FILE END MARKER - cf. Tab. B.1.25.

B.13. CONTENTS OF THE FILES IN THE BUFFER

The records with the results and the records with the state of the markers as well as the records with the breaks in the results registration are saved in the files in the buffer.

B.13.1. Record with the results

The contents of the record with the results depends on the measurement function, selected channels modes, values set in the **BUFFERS SETUP** menu and its sub-lists, channels selected for spectrum analysis and values set in the **BUFFER** position (*path: MENU / INPUT / 1/1 OCTAVE or 1/3 OCTAVE or FFT SETUP / CHANNEL x / BUFFER*). All results are written in dB *10. Profile results are written on 15 most significant bits, while least significant bit is used for overload indication flag. The following elements can be present (in the given sequence):

- results of the measurement from the 1st profile of the 1st channel if the **BUFFERS** list was marked and **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 1 PROF. 1** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 1 / CHAN. 1 PROF. 1*) sub-list was selected, up to five words are written in the given sequence:

<result1> - **PEAK** result in the case of **VLM** or **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **P–P** result in the case of **VLM** or **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MAX** result in the case of **VLM** or **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **VLM** or **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;
<result5> - **VDV** result in the case of **VLM** if the fifth position was marked, else no value is written;

- results of the measurement from the 1st profile of the 2nd channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)*; and if any position in **CHAN. 2**

PROF. 1 (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 2 / CHAN. 2 PROF. 1*) sub-list was selected, up to five words are written in the given sequence:

<result1> - **PEAK** result in the case of **VLM** or **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **P–P** result in the case of **VLM** or **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MAX** result in the case of **VLM** or **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **VLM** or **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;
<result5> - **VDV** result in the case of **VLM** if the fifth position was marked, else no value is written;

- results of the measurement from the 1st profile of the 3rd channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 3 PROF. 1** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 3 / CHAN. 3 PROF. 1*) sub-list was selected, up to five words are written in the given sequence:

<result1> - **PEAK** result in the case of **VLM** or **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **P–P** result in the case of **VLM** or **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MAX** result in the case of **VLM** or **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **VLM** or **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;
<result5> - **VDV** result in the case of **VLM** if the fifth position was marked, else no value is written;

- results of the measurement from the 1st profile of the 4th channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 4 PROF. 1** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 4 / CHAN. 4 PROF. 1*) sub-list was selected, up to five words are written in the given sequence:

<result1> - **PEAK** result in the case of **VLM** or **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **P–P** result in the case of **VLM** or **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MAX** result in the case of **VLM** or **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **VLM** or **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;
<result5> - **VDV** result in the case of **VLM** if the fifth position was marked, else no value is written;

- results of the measurement from the 2nd profile of the 1st channel if the **BUFFERS** list was marked and **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 1 PROF. 2** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 1 / CHAN. 1 PROF. 2*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 2nd profile of the 2nd channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)*; and if any position in **CHAN. 2 PROF. 2** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 2 / CHAN. 2 PROF. 2*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;

<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 2nd profile of the 3rd channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 3 PROF. 2** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 3 / CHAN. 3 PROF. 2*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 2nd profile of the 4th channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 4 PROF. 2** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 4 / CHAN. 4 PROF. 2*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 3rd profile of the 1st channel if the **BUFFERS** list was marked and **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 1 PROF. 3** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 1 / CHAN. 1 PROF. 3*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 3rd profile of the 2nd channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)*; and if any position in **CHAN. 2 PROF. 3** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 2 / CHAN. 2 PROF. 3*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 3rd profile of the 3rd channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 3 PROF. 3** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 3 / CHAN. 3 PROF. 3*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- results of the measurement from the 3rd profile of the 4th channel if the **BUFFERS** position was set to **ON** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON)* and if any position in **CHAN. 4 PROF. 3** (*path: MENU / INPUT / BUFFERS SETUP / CHANNEL 4 / CHAN. 4 PROF. 3*) sub-list was selected, up to four words are written in the given sequence:

<result1> - **PEAK** result in the case of **SLM** if the first position was marked, else no value is written;
<result2> - **MAX** result in the case of **SLM** if the second position was marked, else no value is written;
<result3> - **MIN** result in the case of **SLM** if the third position was marked, else no value is written;
<result4> - **RMS** result in the case of **SLM** if the fourth position was marked, else no value is written;

- **VECTOR** measurement result if in the **BUFFERS** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON*) and **VECTOR** (*path: MENU / INPUT / BUFFERS SETUP / VECTOR:ON*) positions are set to **ON** and **VECTOR** measurement was enabled; one word is written.

- **RPM** measurement result if the **BUFFERS** (*path: MENU / INPUT / BUFFERS SETUP / BUFFERS:ON*) and **RPM** (*path: MENU / INPUT / BUFFERS SETUP / RPM:ON*) positions are set to **ON** and **RPM** measurement was enabled; two word are written.

- results of **1/1 OCTAVE** analysis from the 1st channel if **1/1 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/1 OCTAVE SETUP / CHANNEL 1: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <Octave[1]> <Octave[2]> ... <Octave[NOct+NOctTot]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Octave[i] - the result of **1/1 OCTAVE** analysis (*10 dB); i = 1..NOct+NOctTot (1..18)

- results of **1/1 OCTAVE** analysis from the 2nd second channel if **1/1 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/1 OCTAVE SETUP / CHANNEL 2: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <Octave[1]> <Octave[2]> ... <Octave[NOct+NOctTot]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Octave[i] - the result of **1/1 OCTAVE** analysis (*10 dB); i = 1..NOct+NOctTot (1..18)

- results of **1/1 OCTAVE** analysis from the 3rd channel if **1/1 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/1 OCTAVE SETUP / CHANNEL 3: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <Octave[1]> <Octave[2]> ... <Octave[NOct+NOctTot]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Octave[i] - the result of **1/1 OCTAVE** analysis (*10 dB); i = 1..NOct+NOctTot (1..18)

- results of **1/1 OCTAVE** analysis from the 4th channel if **1/1 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/1 OCTAVE SETUP / CHANNEL 4: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <Octave[1]> <Octave[2]> ... <Octave[NOct+NOctTot]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Octave[i] - the result of **1/1 OCTAVE** analysis (*10 dB); i = 1..NOct+NOctTot (1..18)

- results of **1/3 OCTAVE** analysis from the 1st channel if **1/3 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path MENU / INPUT / 1/3 OCTAVE SETUP / CHANNEL 1: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <Terave[1]> <Terave [2]> ... <Terave[NT]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Terave[i] - the result of **1/3 OCTAVE** analysis (*10 dB); i = 1..NT (1..48 or 1..33)

- results of **1/3 OCTAVE** analysis from the 2nd channel if **1/3 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/3 OCTAVE SETUP / CHANNEL 2: ON / BUFFER*)position other then **None** value was selected; the sequence of words is written:

<flags> <Terave[1]> <Terave [2]> ... <Terave[NT]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Terave[i] - the result of **1/3 OCTAVE** analysis (*10 dB); i = 1..NT (1..48 or 1..33)

- results of **1/3 OCTAVE** analysis from the 3rd channel if **1/3 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/3 OCTAVE SETUP / CHANNEL 3: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <Terave[1]> <Terave [2]> ... <Terave[NT]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Terave[i] - the result of **1/3 OCTAVE** analysis (*10 dB); i = 1..NT (1..48 or 1..33)

- results of **1/3 OCTAVE** analysis from the 4th channel if **1/3 OCTAVE** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / 1/3 OCTAVE SETUP / CHANNEL 4: ON / BUFFER*) position other then **None** value was; the sequence of words is written:

<flags> <Terave[1]> <Terave [2]> ... <Terave[NT]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
Terave[i] - the result of **1/3 OCTAVE** analysis (*10 dB); i = 1..NT (1..48 or 1..33)

- results of **FFT** analysis from the 1st channel if **FFT** analysis was selected as the measurement function and in the **BUFFER** (*path MENU / INPUT / FFT SETUP / CHANNEL 1: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <FFTave[1]> <FFTave [2]> ... <FFTave[NL]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
FFTave[i] - the result of **FFT** analysis (*10 dB); i = 1..NL (1..481 or 1..961)

- results of **FFT** analysis from the 2nd channel if **FFT** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / FFT SETUP/ CHANNEL 2: ON / BUFFER*)position other then **None** value was selected; the sequence of words is written:

<flags> <FFTave[1]> <FFTave [2]> ... <FFTave[NL]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
FFTave[i] - the result of **FFT** analysis (*10 dB); i = 1..NL (1..481 or 1..961)

- results of **FFT** analysis from the 3rd channel if **FFT** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / FFT SETUP / CHANNEL 3: ON / BUFFER*) position other then **None** value was selected; the sequence of words is written:

<flags> <FFTave[1]> <FFTave [2]> ... <FFTave[NL]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
FFTave[i] - the result of **FFT** analysis (*10 dB); i = 1..NL (1..481 or 1..961)

- results of **FFT** analysis from the 4th channel if **FFT** analysis was selected as the measurement function and in the **BUFFER** (*path: MENU / INPUT / FFT SETUP / CHANNEL 4: ON / BUFFER*) position other then **None** value was; the sequence of words is written:

<flags> <FFTave[1]> <FFTave [2]> ... <FFTave[NL]>
where:
flags = 1 - the overload detected, 0 - the overload not detected
FFTave[i] - the result of **FFT** analysis (*10 dB); i = 1..NL (1..481 or 1..961)

The value of NT parameter depends on the **BUF. STEP** selection (*path: MENU / INPUT / MEASURE SETUP*). For the buffer steps greater then 10 ms the value of NT is equal to NTer+NTerTot: the outputs from all **1/3 OCTAVE** filters from 0.8 Hz up to 20 kHz and the TOTAL values are written (45 + 3 = 48). For the buffer step equal to 10 ms the value of NT is equal to 33: the outputs from **1/3 OCTAVE** filters from 25 Hz up to 20 kHz and the TOTAL value are written (30 + 3 = 33).

The value of NL parameter depends on the **LINES** selection (*path: MENU / INPUT / FFT / CHANNEL X / LINES).*

B.13.2. Record with the state of the markers

The record with the state of the markers consists of one word:

<0x8nnn>

in which 12 bits nnn denote the state of the markers:

b11 = state of #12 marker
b10 = state of #11 marker
...
b1 = state of #2 marker
b0 = state of #1 marker

B.13.3. Record with the breaks in the results registration

The record with the breaks in the results registration consists of four words:

<0xB0ii> <0xB1jj> <0xB2kk> <0xB3nn>

in which ii, jj, kk, nn bytes denote 4-bytes counter of left or skipped records: nnkkjjii (ii is the least significant byte, nn - the most significant byte).

B.13.4. Record with the breaks account PAUSE in the results registration

The record with the breaks in the results registration consists of four words:

<0xA0ii> <0xA1jj> <0xA2kk> <0xA3nn>

in which ii, jj, kk, nn bytes denote 4-bytes counter duration of PAUSE in milliseconds:
nnkkjjii (ii is the least significant byte, nn - the most significant byte).

Pause duration means time passed between pressing **<PAUSE>** key and measurement continuation key. Start delay after pressing continuation key isn't added to the counter.

B.5. DATE AND TIME

Following function written in C explains how the date and time are coded:

```
void ExtractDateTime(int date, int time, int dt[])
{
      int sec,year;

      sec = ((0xffff&time)<<1); /* time<<1; */
      dt[0] = sec%60; /* sec */
```

```
dt[1] = (sec/60)%60; /* min */
dt[2] = sec/3600; /* hour */

dt[3] = date&0x1F; /* day */
dt[4] = (date>>5)&0x0F; /* month */
year = (date>>9) & 0x07F;
dt[5] = year+2000; /* year */ }
```

Glossary of Terms

A(8)	When analyzing hand-arm vibration and whole-body vibration, A(8) is a type of measurement that computes the average over 8 hours. The partial 8-hour time-weighted average exposure is calculated on the following formula: • Aeq x $\sqrt{(T/T_0)}$ ▪ Aeq is the measured average acceleration value in m/s^2 from the measured vibration sample. ▪ T is the actual total daily exposure time for the subject tool. ▪ T_0 is the daily work shift (8 hours).
Acceleration	The time rate of change in velocity measured by ft/sec2 or m/sec2 or gravity. ($1g=9.81m/sec^2$)
Accelerometer	A sensor used to measure the x, y, z axis vibration. Two types of accelerometers are: • Charge Mode • Voltage Mode - ICP
ACGIH	American Conference of Governmental Industrial Hygiene is a committee of experts that oversee and make recommendations based on environmental industrial hygiene and occupational health for workers health and safety. ACGIH defined the following threshold levels for human vibration: ***Hand-arm vibration*** 5 – 1500 HZ ***Whole-body vibration*** 1 – 80 HZ
Aeq	For HAV and WBV measurements, AEQ is the single number of the acceleration energy equivalent for the test time. (ex: test time is 10 mins.)
Amax	For HAV and WBV measurements, AMAX is the maximum acceleration level on meter.
Amin	For HAV and WBV measurements, AMIN is the minimum accelerated level.
Arms	For HAV and WBV measurements, Arms is the single number of the acceleration energy equivalent for the test time. (ex: test time is 10 mins.) The vibration meter samples a constantly changing weighted signal from the accelerometer many times per second and converts those samples into an "average" value that is updated on the instrument display at some fixed frequency, typically once per second. This "average" is actually computed as the **s**quare root of the average (**m**ean) of the squares of the samples, thus acronym "rms".

Axis	Vibration can occur up and down, forward and backward, and left and right. These three types of directions are called axis.
Calibration	The process of adjusting an instrument to a known calibrated source. An accelerometer will come with a *calibration certificate* that states the defined sensitivity. For example, for a 10 mV/g accelerometer, you may see actual sensitivities of 9.95 mV/g or 10.23 mV/g.
Crest Factor (CRF)	For Whole-Body vibration, this is the ratio of the maximum peak value of the frequency weighted acceleration signal to the root-mean-square (RMS) value. • crest factor = $\frac{peak}{rms}$
Criterion Level	The maximum allowable exposure to the accumulated noise or vibration; it gives the condition that will result in the 100% dose.
Damping	A means of dispersing vibration energy within a vibrating system.
Displacement	The distance between the normal resting position of an object and its position at any given time in a vibration cycle.
EAV **ELV**	**Exposure Action Value** is the daily exposure limit value for HAV and WBV in an eight hour interval derived by the European Union directive. The following are the action levels: *Hand-Arm Vibration* **EAV** 2.5 m/s^2 *Whole-Body Vibration* **EAV** 0.5 m/s^2 **Exposure Limit Value** is the maximum exposed level set by European Union based on an eight hour interval. The following are the action levels: *Hand-Arm Vibration* **ELV** 5.0 m/s^2 *Whole-Body Vibration* **ELV** 1.15 m/s^2

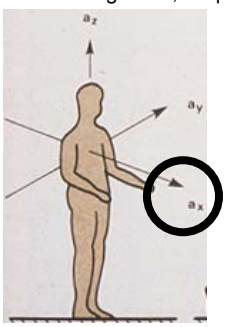
EU	**European Union** – applied easy to follow guidelines for whole-body vibration and hand-arm vibration. This consists of an exposure action level limit (EAV) and a daily exposure limit (ELV).
Fast Fourier Transform	When analyzing measured HAV and/or WBV, FFT may be applied to understand the frequency content of the vibration source in miniscule detail. A ***Fourier Frequency Domain Spectrum*** is a radically fine scale that quantifies the vibration acceleration rates according to frequency.
Frequency	Cycles per second usually displayed in Hertz (HZ).
HAV	***Hand-Arm Vibration*** is vibration transmitted from work processes into workers hands and arms. Some of the causes are from operating hand-held power tools such as pneumatic, electric, hydraulic & gas-powered tools.
HAVS	***Hand-Arm Vibration Syndrome*** is permanent injuries to your hands and arms which can include the following: • Sensory nerve damage – damages to the nerves in your fingers which may cause permanent numbness or tingling in your fingers. • Blood circulatory systems – The first signs is an occasional attack when your fingertips turn white. During an attack, your fingers may also become numb and feel like "pins and needles". This is very painful and your fingers may change to a red flush. • Damage to the muscle, bones, and joints – you may notice a loss of strength in your hands and pains in your wrists and arms.
ISO	International Standards Organization which defines the standards for human vibration and sound.
ISO 8041	A performance standard directed at instrument manufacturers. It defines the accuracies that an instrument for this application shall meet in accordance with the threshold limit value (i.e., tolerance limits) to address human response to vibration.
ISO5349	Procedural standards defined by International Standards Organization for hand-arm vibration. Standard for total daily exposure is defined below: **Total Daily Exposure Duration** / **Max Frequency-Weighted RMS X_h, Y_h, or Z_h** • 4 hours and less than 8 hours — 4 m/s^2 • 2 hours and less than 4 hours — 6 m/s^2 • 1 hour and less than — 8 m/s^2 • Less than an hour — 12 m/s^2
IS02631	Procedural standards defined by International Standards Organization for the Whole-Body Vibration which defines the range of frequency weight as: • 0.5HZ – 80HZ for WBV
Isolation	The reduction of vibration by the intentional separation of mechanical transmission between source and receiver.
MTVV	When analyzing exposure to hand-arm vibration and/or whole-body vibration, the MTVV is the maximum transient vibration value (same as Amax).

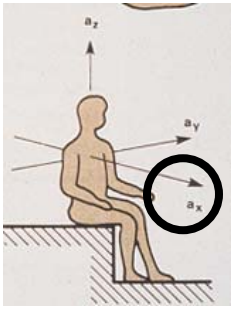
Magnitude	The vibration magnitude tells how "powerful" the vibration is. Usually the magnitude of vibration is indicated by the acceleration 'a', measured in meters per second squared (m/s²). Because the magnitude of the acceleration is continually changing, a single overall value was introduced. In most cases, when vibration does not contain shocks, the acceleration magnitude is expressed by the root-mean-square (rms) value. $a_{rms} = \sqrt{\frac{1}{T}\int_0^T a^2(t)dt}$
NIOSH	***National Institute for Occupational Safety and Health*** reviews, evaluates, and disseminates new information on occupational hazards.
Occupational Vibration	Whole-body vibration and hand-arm vibration in the workplace.
1/3 octave	A filtered measurement which divides the instrument's broadband spectrum exactly into 33 band-limited frequency ranges.
P-P	For HAV and WBV measurements, P-P is denoted as "Peak to Peak" which displays the highest point value to lowest point value.
Peak	For HAV and WBV measurements, Peak is the highest point value.
Resonance	The human body's tendency to act in concert with externally applied vibration and exacerbate (i.e., amplify) its effects. (The effects of the vibration in certain frequency when in contact with various hand tools.)
Resonance frequency	With HAV and WBV applications, a resonance frequency is a natural frequency of vibration determined by the physical parameters of the vibrating object and associated with the human body response.
RMS	Root Mean Square is the statistical measure of the magnitude of a varying quantity (Arms for acceleration).
Sensed Calibration	A calibration done with a shaker calibrator.
Tri-Axial Accelerometer	Vibration transducers that contain three separate accelerometers (x,y,z axes) within one physical instrument (housing).
TLV	***Threshold Limit Value*** – Defines exposure level limits for Hand-Arm and Whole-Body vibration.

Vector	A quantity that is completely determined by its magnitude and direction.
Vector Sum	This is the square root of the sum of the squares of the weighted rms acceleration values of x, y, and z axes. Vector Sum is a vibration total value of all three axes. Vector Sum is recommended for use when no dominant axis exists. Vector Sum is also prescribed for use over most-dominant-axis values in some regulations.
Velocity	The steady rate (or speed; i.e. a car) measured in meters per second (m/s).
VDV	Vibration Dose Value is a method used to calculate vibration exposure. It is more sensitive to peaks than standard evaluation methods and should be used when crest factors are greater than 9. The EU WBV guidelines are defined as the following: • **Daily Exposure Limit** – 1.15 m/s2 A(8) or 21 m/s1.75 VDV • **Daily Exposure Action Value** – 0.5 m/s2 A(8) or 9.1 m/s1.75 VDV
WBV	***Whole-Body Vibration*** is a form of mechanical vibration transmitted through a supporting surface to the body. For example, heavy equipment vibration is transmitted through the seat of the vehicle to the operator's spine. Exposed groups include operators of trucks, buses, tractors, aviation workers, and people working on vibrating floors. WBV is hazardous when there is regular and frequent exposure to high levels of vibration (typically over several years). The benchmarks are: • 4 to 8 Hz Resonance Head-to-toe • 1 to 2 Hz Resonance Left/Right & Front/Back
W_k	WBV vibration is generally adjusted, or weighted, so that the instrument's frequency follows a characteristic curve for the z-axis (vertical, seat surface).
W_d	WBV vibration is generally adjusted, or weighted, so that the instrument's frequency follows a characteristic curve for the x-axis and y-axis (horizontal, seat surface).
Weighting	According to the ISO2631, it is the range of frequency weight (0.5HZ – 80HZ for WBV) (5HZ-1,500 for HAV). (For example, the weight is how the vibration corresponds to the sensitivity of a person.)

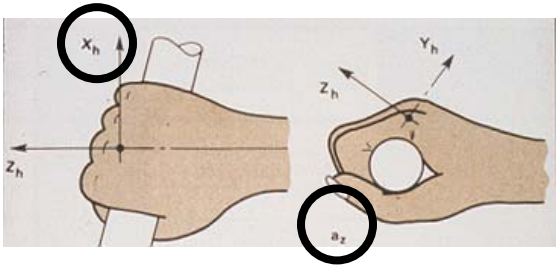
X- Axis

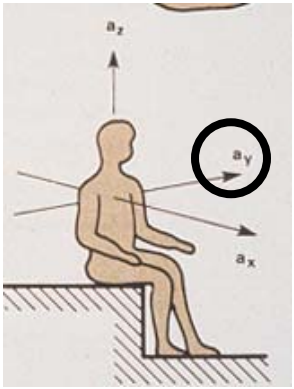
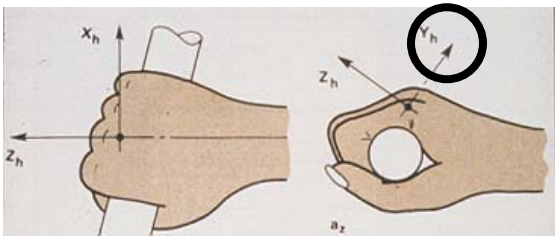
For detecting WBV, frequency is measured from **back-to-chest**

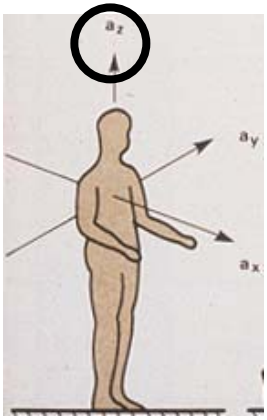
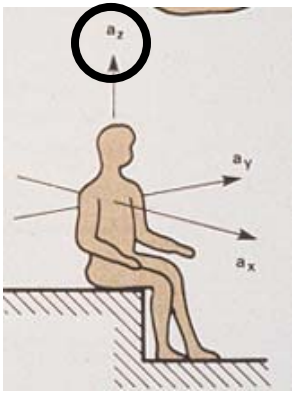
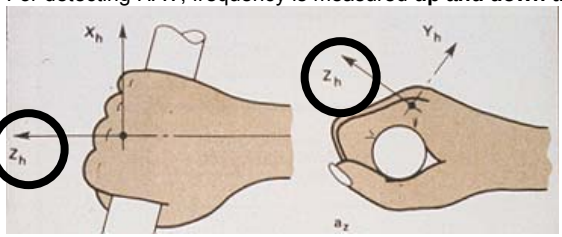




For detecting HAV, frequency is measured **through the back of the hand**



Y-Axis	For detecting WBV, frequency is measured from **right-to-left side**  For detecting HAV, frequency is measured **across the knuckles** 

Z-Axis	For detecting WBV, frequency is measured from **head-to-toe**   For detecting HAV, frequency is measured **up and down the arm** 

Quest Service

Contacting Quest Technologies

Should your Quest Technologies equipment need to be returned for repair or for recalibration, please contact the service department at the following number or access the online form via the website.

- **Service Department:** 1 (800) 245-0779. Office hours are 8:00 a.m. to 5:00 p.m. United States Central.
  - Contact Quest via e-mail at mailto:sales@quest-technologies.com
  - **Fax:** +1 262/567-4047
    - ✓ Request a **Return Authorization number**.
- **Internet:** www.quest-technologies.com

If you have questions about the calibrator's operation, please contact Quest Technologies and ask for Technical Support.

- **Telephone:** +1 262/567-9157 or 800-245-0779 within the USA

International customers

Contact your local, factory-authorized distributor from whom the product was purchased. You can obtain the name and contact information of your local factory-authorized distributor from Quest by using the e-mail, telephone, or fax information given under "Contacting Quest Technologies" above.